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HEALTHY EATING BEHAVIORS FOLLOWING A CULTURALLY SENSITIVE
NUTRITION EDUCATION INTERVENTION FOR HISPANIC FAMILIES

BY

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THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Nutritional Sciences
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2017

Urbana, Illinois

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ABSTRACT

Background

Across the lifespan, Hispanics in the United States (US) suffer from higher prevalence of obesity than the general population. Efforts to prevent the development of obesity among children in this at-risk group have had mixed success. Cultural tailoring, such as inclusion of Hispanic cultural values and traditional foods, has proved to be successful in the modification of obesogenic behaviors among Hispanic youth. Though overall diet quality in Hispanic adults and children, assessed through tools such as the Healthy Eating Index, is high, this group consumes the highest reported intakes of sugar-sweetened beverages (SSB) and saturated fats. Nutrition education interventions are needed to address these two problem areas, which can contribute to weight gain in Hispanic children. In addition to increased obesity burden, Hispanics are at additional risk for related comorbidities, including type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD). The proportion of individuals without health insurance is also highest in Hispanics compared to any other ethnic group in the US, indicating that rates of these diseases could be much higher. Health screenings and educational tools are needed to allow these individuals to understand and be aware of their risk for disease, so they can seek medical attention or adopt lifestyle change. The objective of this thesis is to adapt, deliver, and evaluate a family-focused, culturally-sensitive nutrition education program for the prevention of childhood obesity in Hispanic families, and to conduct a minimally-invasive cardiovascular and metabolic health screen in this population.

The Abriendo Caminos (AC2) nutrition education curriculum was adapted to reflect applied behavior theory, community feedback, and advances in evidence-based nutritional guidance. This was done through literature search and review of theory-based educational

interventions, structured focus groups and communication with community leaders, and review of position statements and policy documents regarding adoption of healthy dietary patterns and prevention of obesity in adults and children. The AC2 nutrition curriculum included elements of Social Cognitive Theory (SCT) through interactive activities including skill-building, content reinforcement, and immediate assessments. Cultural tailoring and community feedback were reflected in the foods used for examples and content added to lectures. Recent nutrition evidence was added specifically in the adult lessons, where the facilitator could teach concepts in greater depth than in the child lessons.

The evaluation phase of AC2 took place following adaptation and delivery of the curriculum. AC2 is a randomized control trial, in which participants in the intervention group are enrolled in a six-week workshop series on topics related to nutrition, physical activity (PA), and family togetherness. The abbreviated attention control group received three workshops on topics unrelated to health. Survey data and anthropometric measurements were taken at baseline (T0) and after the intervention period (T1). Dietary intake was collected through semi-quantitative food frequency questionnaires, and diet quality was evaluated through adherence to the 2015 *Dietary Guidelines for Americans* (HEI-A) and to a low-fat diet in mothers. In children, weekly consumption of SSB, fast food, fruits, and vegetables was compared at T0 and T1 between experimental groups. Compared to the control group, mothers in the intervention reported increases in HEI-A scores from a 44.7 ± 13.5 to 66.1 ± 13.5 ($P < 0.01$), and in limiting calories from saturated fat and increasing consumption of low-fat dairy. Children in the intervention group also significantly decreased their SSB consumption from 6.7 to 2.7 times per week ($P = 0.003$). Also, prevalence of obesity and overweight in children enrolled in the AC2 intervention did not increase at T1. In children in the control group, prevalence of both

overweight and obesity increased at T1. These changes in weight were not statistically significant.

Adults and children were invited to participate in a health screen in which values for total and high-density lipoprotein cholesterol, triglycerides, glucose, and hemoglycosylated A1C were measured through a finger stick procedure. Blood pressure and body composition were also measured, the latter through bioelectrical impedance analysis. Descriptive statistics were calculated for all measures and compared to the national prevalence of risk factors such as hypercholesterolemia, dyslipidemia, hypertension, T2DM, and obesity. Both adults and children had high values for percent body fat (PBF), with 71% of males and 76% of females having PBF above PBF levels recommended for optimal health. Children were categorized as high- or low-risk by PBF for age and sex. In this sample, 78% of boys and 88% of girls were determined to be in the high-risk category. There was also high prevalence of high blood pressure in children, determined by age, sex and height specific growth charts. Half of boys and 25% of girls in this sample had blood pressure values greater than the 90th percentile, likely secondary to high obesity rates in this population.

Interventions to prevent the development of obesity in Hispanic children are needed, as this group is at increased risk for obesity and related comorbidities. When designing interventions for this group, consideration of sound behavior theory, the individual needs of the community, and cultural values are of utmost important. This intervention was successful in improving dietary behaviors in participants and preventing weight gain in children in the short term. However, because this population also has high prevalence of hypertension and obesity-related comorbidities, there is a need for long-term follow-up and continued attention to improving the health of the Hispanic population.

ACKNOWLEDGEMENTS

I would like to start by thanking my advisor, Dr. Margarita Teran-Garcia, for giving me the opportunity to pursue a degree at the University of Illinois. Thank you for all your guidance, advice, and patience with me as I navigated through my first two years here. Thank you for pushing me out of my comfort zone and having confidence in me. I would also like to thank the rest of the Abriendo Caminos research team: Dr. Angela Wiley, Elizabeth Villegas, Michelle Cruz-Santiago, Stephany Hove, Viridiana Luna, Brianna Franklin, and everyone who has played a part in this program. Dr. Nickols-Richardson, thank you for your mentorship both in development of my writing and your support in my application of the ASN science policy fellowship. I am very grateful to be mentored by someone with your experience and insight. Dr. Naiman Khan, thank you for your support both as a mentor on my committee, but also in your guidance through the dietetics program and professional development. Dr. Donovan, thank you for your insight and feedback, and your continued support. To the faculty who have provided recommendations, insight, or support to me, thank you.

I would also like to thank my labmates both past and present, specifically Courtney Marques, Anthony Wang, Viridiana Luna, and Katie Robinson. This would not be possible without your teaching and support during this process. Katie, thank for all your unofficial mentoring and laughs we have shared both in and out of the office. To my friends, Jan Lumibao, Erin Davis, John Mathai, and the rest of DNS who have supported me along the way. And as always, none of this would be possible without my parents, stepparents, and siblings. Lastly, thank you to the Division, Drs. Johnson and Hartke, Ashley, and Sarah, for this opportunity, and for all you do for the Division.

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LIST OF ABBREVIATIONS

AC	Abriendo Caminos
AC2	Abriendo Caminos 2 (specifically, the adapted curriculum)
A-HEI	Alternate Healthy Eating Index
ARSMA	Acculturation Rating Scale for Mexican Americans
APN	<i>Aventuras Para Niños</i> intervention
BMI	body mass index
CBPR	community-based participatory research
CVD	cardiovascular disease
DGA	<i>Dietary Guidelines for Americans</i>
EAL	evidence Analysis Library
EBP	evidence-based practice
GMO	genetically modified organism
HbA1C	hemoglycosylated A1C
HDL	high-density lipoprotein cholesterol
HEI	Healthy Eating Index
HEI-A	Healthy Eating Index for Adherence to the 2015 DGA
MetS	metabolic syndrome
LDL	low-density lipoprotein cholesterol
NSFS	<i>Niños Sanos, Familia Sana</i> intervention
PA	physical activity
SCT	social cognitive theory
SFA	saturated fat
SOL	Study of Latinos
SSB	sugar-sweetened beverages
T2DM	type 2 diabetes mellitus
TC	total cholesterol
TG	triglycerides
US	United States

Chapter 1: Introduction

Obesity rates in the United States (US) are rapidly increasing (1). The obesity epidemic in the US has also been associated in increasing prevalence of comorbid diseases such as type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) (2). Both obesity and these comorbidities disproportionately affect Hispanics, the fastest-growing and largest minority group in the US. Hispanic adults have higher rates of obesity than the general public, and higher rates of T2DM than any other ethnic group in the US (3). Unfortunately this trend extends to Hispanic children, who are also affected by obesity at greater rates than the general population. Lifestyle changes must be implemented at an early age to prevent lifelong complications of obesity and chronic disease. Behavioral interventions that seek to modify dietary and physical activity (PA) habits are the first recommendation by healthcare providers in the prevention and treatment of childhood obesity, before the implementation of pharmacological or surgical interventions (4). Furthermore, the unique barriers to health in Hispanics, such as acculturation, high-energy consumption, and cultural beliefs must be considered when designing preventive programs.

Evidence has shown that culturally-sensitive programs can potentially be more well-received in Hispanics than a generalized approach (5). Traditional Hispanic foods, such as rice, corn tortillas, beans, and *nopales* (cactus) are culturally relevant examples of favorable food choices that can be used in nutrition lessons. Values central to Hispanic culture, such as the high regard for family, personal interaction, and trust are all elements to be included when developing culturally-sensitive interventions. Programs that target the family unit have also proven to be effective in behavior change for Hispanic families (6). Other components of successful interventions for obesity prevention in Hispanic children include hands-on demonstrations, high levels of interaction, and the implementation of small changes rather than dietary restriction.

Interventions that include these behavioral and social components are needed to continue to prevent the development of obesity.

To address the disproportionate rates of childhood obesity among Hispanic families, researchers at the University of Illinois developed *Abriendo Caminos*, a six-week behavioral intervention for Hispanic families. *Abriendo Caminos* enrolled 78 parent-child dyads in workshops which taught nutrition, family mealtimes, and PA (7). The theoretical framework was rooted in social cognitive theory (SCT), cross-cultural psychology, and the family resiliency approach. The nutrition curriculum was interactive and culturally-tailored, including food demonstrations and healthier versions of traditional recipes. It was based on the *2005 Dietary Guidelines for Americans* (DGA). The primary outcome of the pilot study was to improve eating behaviors in children. *Abriendo Caminos* was successful in increasing fruit and vegetable consumption and decreasing SSB consumption among children, demonstrating the initial effectiveness of modification of dietary behaviors in this population. In 2015, the program expanded to a multi-site, USDA/NIFA sponsored five-year program: AC2. The new AC2 is a randomized control-trial prevention program, with the intervention group receiving six workshops on nutrition, family togetherness, and PA, and implementation of an abbreviated attention control group. The AC2 nutrition education curriculum was modified to include additional elements of behavior theory strategies, community feedback and cultural tailoring, and advances in nutrition research. The adaptations made to the nutrition curriculum, and the theoretical, cultural, and scientific basis behind these changes, are discussed in **Chapter 4**.

The primary outcomes of AC2 are to improve dietary patterns among families and prevent excessive weight gain in children enrolled in the intervention group, assessed through data collection at baseline (T0), post-intervention (T1) and six months post-intervention (T2). In

epidemiologic studies, Hispanics, specifically Mexican-Americans, have reported higher diet quality than the other ethnic groups, due to their high scores in the categories of fruit, vegetable, and legume consumption, despite high consumption of energy-dense foods such as SSB (8). Diet quality in our study was assessed through adherence to the key recommendations of the 2015 DGA (HEI-A) (9). Fat intake was also assessed through the use of semi-quantitative food frequency questionnaires (SQFFQ). The American Heart Association, the Dietary Guidelines Advisory Committee, and other expert committees and review papers have published substantial evidence for the replacement of saturated fat with unsaturated fat in the diet, instead of the adoption of a low-fat diet, which was previously the accepted recommendation to prevent excessive weight gain (10). Dietary assessment data and changes in eating patterns and anthropometric measurements are presented in **Chapter 5**.

As mentioned above, Hispanics are at increased risk of obesity-related diseases. Hispanics experience higher rates of T2DM and hypertension compared to the general US population (11, 12). Secondary outcomes of AC2 were to examine the cardiometabolic health of participants enrolled in the program through minimally-invasive health screens. Through assessment of additional outcomes such as body composition analysis, glucose, hemoglycosylated A1C, lipid profiles, and blood pressure, we were able to further examine the objective and biological health of participants at baseline. There is substantial evidence linking certain aspects of an unhealthy diet, including high sugar and high energy consumption, with increased risk of cardiometabolic disease (13). These results are further discussed in **Chapter 6**.

There is a need to further explore the biological and behavioral processes at work behind obesity progression and weight gain in at-risk, understudied populations. By understanding the

unique barriers to health faced by Hispanic families, intervention programs can continue to be developed and refined for maximum benefit.

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Chapter 2: Review of Literature

The following review of literature serves to provide background and justification for the research proposed in this thesis. Health disparities experienced by Hispanics in the United States, the current state of obesity prevention efforts in Hispanic children and families, and the theoretical framework for such behavioral interventions are discussed.

The prevalence of obesity in the United States (US) has been exponentially increasing over the past 30 years; currently 36% of US adults and 17% of children aged 2-19 years are living with obesity (1, 2). Obesity is associated with over 20 comorbid diseases including T2DM, dyslipidemia, hypertension, and certain types of cancers (3). MetS is a cluster of risk factors for diseases including dyslipidemia, hypertension, and hyperglycemia, and has been associated with obesity risk (4). As obesity rates rise, so does the prevalence of related diseases in the US (5-7). This complex disease is also related to decreased life expectancy of up to nine years in Caucasians and six years in African-Americans (8). However, Hispanics have longer life expectancy than both these ethnic groups at any BMI, referred to as the Hispanic Health Paradox (9). This paradox is also observed among individuals with cardiovascular disease (CVD). Although Hispanics have on average a lower socioeconomic status and higher risk profile for CVD progression, the rates of CVD mortality are lower in Hispanics than the general US population. There also is evidence that longer life expectancy, despite poor health, is mediated by psychological factors such as social support and high family resiliency, both of which can be beneficial in increasing healthy behaviors in this population (10).

Obesity is defined by the accumulation of excess body weight that poses a risk to health and is diagnosed by a body mass index (BMI) greater than 30 kg/m^2 in adults over the age of eighteen (11). In children, obesity is diagnosed through comparison to age-and-sex specific

growth charts. A BMI percentile greater than or equal to the 95th percentile is within the obesity range (12). BMI is calculated by the height and weight of an individual, and thus is a non-invasive and convenient way to assess obesity risk. However, BMI does not provide insight into an individual's fat distribution, as does a body composition analyzer (13). Because of the association of increased abdominal adiposity with CVD and MetS risk, measuring abdominal obesity through either waist circumference or bioelectrical impedance analysis is also often done when assessing cardiovascular or metabolic risk (14, 15).

The rise in prevalence of obesity may be partially attributed to decreased physical activity (PA) and increased consumption of energy-dense, nutrient-poor foods, resulting in a positive energy balance and subsequent weight gain (16). Obesity can be attributed to a combination of bio-behavioral factors such as genetic predisposition, family involvement, accessibility to healthy food or places to exercise, and culture (17). These factors must be taken into consideration when addressing the obesity epidemic in at-risk populations.

Health Disparities among Hispanic Americans

The US Census Bureau defines the Hispanic, or Latino, ethnonym as any person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin (18). Hispanic-Americans are the largest minority in the US, and constitute 17% of the total US population (19). And despite longer reported lifespan, Hispanics have higher obesity rates than the general population in both adults and children, 42.5% compared to 34.9%, and 22.4% compared to 19.9%, respectively (20). In addition to increased obesity rates, Hispanics also have increased prevalence of T2DM, CVD, and hypertension (6, 21). Hispanic men have the highest rate of hyperlipidemia of any ethnic group in the US, with 39% having low-density lipoprotein cholesterol (LDL-C) levels greater than 130 mg/dL (6). Hispanics with abnormal waist

circumference (>35 inches for women or >40 inches for men) had higher values of other CVD-related biomarkers in the Study of Latinos (SOL) cohort, which is the largest study of Hispanic Americans to date (22). Though many genetic, metabolic, and behavioral factors contribute to the progression of obesity and related disease, this review will focus on the sociocultural factors experienced by Hispanics that contribute to weight gain and disease risk (20).

Sociocultural Factors Contributing to Obesity in Hispanics

In addition to a positive energy balance resulting in weight gain, there are sociocultural factors unique to Hispanics that contribute to the disproportional rates of obesity that are not experienced by other ethnic groups, and can serve as barriers to achieving a healthy weight. Several of these are described here, including acculturation, parenting styles, and cultural beliefs.

Acculturation is the process by which immigrants are influenced by their new country of residence, and has been defined in research settings as years lived in the US, primary language spoken in the home, or through validated measures such as the Acculturation Rating Scale for Mexican-Americans (ARSMA) (23-25). The use of scales such as ARSMA and the updated ARSMA II allow for acculturation to be assessed on multiple questions such as language spoken, media preference, and social networks and gives a more detailed description of assimilation into the US culture than what can be deduced from demographic information alone (26). Acculturation is a large factor in the development of obesity in many Hispanics who move to the US (27). The obesogenic food environment of the US, with large portion sizes, high sugar intake, and low PA levels, often leads to excessive weight gain in immigrants. Previously cited reasons include lack of time to exercise or prepare food, more choices for fast food, and less healthy options for food, such as fruits and vegetables (28). The traditional Hispanic diet of corn tortillas, beans, fruits, and vegetables is replaced by the Western diet of red meat, refined grains, and

sugar (29). A traditional Mexican diet is also very high in fiber, and has been shown to be protective against inflammation and weight gain, especially when compared to Mexican-Americans consuming a Western diet (30, 31). In a study exploring the dietary patterns of Mexican-Americans, time spent in the US was associated with higher intakes of saturated fat, sugar, and more energy-dense, nutrient poor foods (30). This shift towards foods not commonly consumed in the Mexican diet such as pizza, processed foods, and sugar-sweetened beverages (SSB), results in weight gain in adults and children (23, 29). Acculturation levels of parents are key determinants in the diet quality of children, and higher acculturation in parents has been associated with poor diet quality and high consumption of SSB in children, in as short as one generation from immigration (32, 33). Mexican-American mothers have expressed concerns relating to the adverse effects of acculturation and the US influence over their children's weight and health, including poor diet choices and desire to consume more non-traditional foods (34).

However, acculturation has also been shown to decrease obesity and comorbid disease prevalence among immigrants. Acculturation is often accompanied by higher education, social mobility, and healthier food choices (35). In the case of obesity-related comorbidities, Hispanics achieving a higher level of education were at decreased risk for T2DM (36), but time spent in the US was also associated with increased risk for T2DM. Because of these conflicting results on the influence of acculturation, researchers and those providing care to Hispanic populations should consider not only time in the US, but also cultural beliefs and preferences of the target population, as these may differ between Hispanic subgroups or regions of the US.

Hispanic cultural beliefs also influence behaviors related to health and food intake. In addition to indulgent feeding practices of Hispanic mothers, many mothers also use food as a reward for achievement or good behavior when offering snacks to their children, which can also

lead to overindulgence, as well as unhealthy eating habits in later life (37). Furthermore, Hispanics are more likely to inaccurately estimate their weight and the weight of their children, underestimating in both cases (38). Parents often view thin children as “unhealthy”, and consider a “healthy” child one that is overweight, indicative of parents’ inability to identify a healthy weight in children (39). Mexican-American mothers have demonstrated low levels of knowledge regarding the causes of obesity, or its associated health risks in children (40, 41). Often, traditional Mexican recipes do not use strict measurements or portion sizes, creating risk for overconsumption and positive energy balance (42). There also is a large emphasis on the maternal role of making sure that children are well-fed, often contributing to overeating and dysregulation of energy balance (43). Other areas of misinformation include the belief that fruit-flavored drinks, such as sports drinks, or the Mexican fruit drink, “Tampico”, are healthy when in fact they are high in sugar and have little nutritional value (44).

In Mexican and Puerto Rican culture, women hold very traditional roles within the home, and patriarchal authority is still very present in the family structure. Because of this, Hispanic women are less likely to engage in PA for reasons such as lack of time due to family obligations, lack of childcare support, or belief that it is unfeminine (45). Hispanic mothers also often put the health needs of their family above their own (46). This may explain why family-focused interventions are often more successful than those targeting one individual in Hispanics (35). If mothers can learn that taking care of their own diet and lifestyle choices will benefit the family, they may be more willing to implement recommended changes. The role of family in Hispanics must be considered when developing obesity prevention interventions. Family support is a key predictor of healthy behaviors in Hispanic families, and parents can serve as role models and supporters in the development of healthy eating patterns in children (32, 47).

Dietary Factors Contributing to Weight Gain in Hispanics

In an epidemiologic study, Hispanic adults had higher reported consumption of fruits and vegetables compared to both non-Hispanic whites and blacks (48). However, this group also had the highest reported intakes of solid fats and added sugars than any other ethnicity, a trend also seen in Hispanic children. This study used the National Health and Nutrition Examination Survey (NHANES) cohort, which is a large sample size, but somewhat unrepresentative of the Hispanic population in the US. NHANES also does not distinguish between Hispanic subgroups. Another study examined diet quality among a variety of Hispanic subgroups in the SOL cohort and found that Mexican-Americans had the highest diet quality, measured by Alternative Healthy Eating Index (A-HEI) compared to other Hispanic subgroups (49). The A-HEI 2010 assessed quality of diet based on the 2010 Dietary Guidelines from Americans, and requires an individual to consume a certain quantity of each food group in order to receive the maximum score (50). A higher A-HEI was also associated with a reduction of MetS risk in this cohort, which is considered a representative sample, as it includes individuals from multiple locations across the US and Hispanic subgroups. Other studies also found that Mexican-Americans had higher alcohol consumption compared to other Hispanic subgroups, but higher intake of whole grains (51). Poor diet quality accounts for around half of all CVD and T2DM-related deaths in Hispanics (52). It is clear that the diet quality may be adequate compared to other groups, there are specific areas still in need of improvement.

SSB including sodas, sports drinks, and fruit-flavored beverages, are still a major energy source for Hispanics, who are more likely to consume SSB than non-Hispanic whites at any age (53). SSB intake has been associated with increased risk of obesity and T2DM in Hispanic children as young as ten years (54-56). SSB consumption is even higher among children of

parents with overweight or obesity. In a population of Hispanic adults diagnosed with T2DM, SSB comprised up to one-tenth of daily caloric intake (57). It is evident that high SSB consumption is a widespread problem in the Hispanic community, and contributes to high energy intake and increased risk of obesity and T2DM.

In a study by Watt et al., women across all ethnicities were not meeting recommended servings per day for fruits and vegetables and were consuming energy-dense diets high in processed foods (58). Parents often serve as the gatekeepers of food for their children and have control over what types of foods their children have access to in the home. Hispanic children especially are highly influenced by their parents' food choices and home food availability. If parents consume fruits and vegetables regularly or have these foods in the house, children will consume them (32). However, this effect was also seen if parents kept energy-dense snacks or SSBs in the house. Parents serve as role models for their children in both healthy and unhealthy behaviors, as previous evidence has shown that children of parents with obesity or related disease such as hypertension had children who consumed higher amounts of energy-dense, nutrient poor foods (24, 59). It is possible that obesity can be prevented in Hispanic children partially through education on the components of a healthy diet, with additional discussion for parents to understand their role in the development of their child's eating habits.

Current Strategies for Obesity Prevention in Hispanics

Recent research has begun to identify effective strategies to prevent obesity progression in at-risk Hispanic families. Obesity is a complex disease, involving a combination of biological and behavioral contributors, and interventions should also cross multiple domains to address the complexity of the disease. Specific to the prevention of obesity in children, multiple outlets, including support from the family, school, and community are examples of domains which can

be locations for interventions (60). Another model that has been proposed for the study of and interventions in childhood obesity is the Six C's Model, adapted from Bronfenbrenner's social-ecological model (61). This model proposes the integration of overlapping domains that contribute to weight gain in childhood across psychological, behavioral, and biological contexts, from cultural to cellular (genetic) influences that interact across the lifespan. Integration of multiple aspects in these domains is expected to result in more successful preventative interventions relative to those that only assess one domain. Specific to Hispanics, some of these domains are the inclusion of family, the role of culture, and family mealtimes. These three factors all focus on family more than the individual. This idea of inclusion is based on the value of *familismo*, the term for the strong ties to family unique to Hispanic culture (62). *Personalismo*, or "formal friendliness" is another core value of Hispanic culture and reflects the importance of building rapport with people through direct communication and a caring manner. Both of these values are reflected in the use of community members to serve as liaisons in culturally-competent interventions for this population (63). Hispanic families expect to encounter friendly, honest, and respectful healthcare providers or interventionists, and messages of behavior change may be more well received if these techniques are employed.

Attention to Hispanic culture is very important in designing successful preventative interventions. Examples of culturally-tailored interventions include those given in both Spanish and English, those that use culturally-relevant foods, and PA through traditional dances such as salsa, cumbia, or samba. Another commonly used tool in culturally-sensitive interventions is the use of *promotoras*, or someone who has established rapport and has gained the trust of the participants. *Promotoras* are often more favorably perceived by the families (64).

Behavioral Interventions in Hispanic Families

Many interventions have been conducted in Hispanic families to prevent or treat childhood obesity. The interventions discussed in this literature review were conducted in Hispanic or primarily Hispanic (> 50% of participants) children ≥ 5 years of age, published within the last five years (**Appendix A**). Common intervention settings included homes, community centers, schools, a physician's office, or a combination of settings, and were delivered by school teachers, health professionals (dietitians, physicians, or physical therapists), trained facilitators, *promotoras*, or extension specialists. Social Cognitive Theory (SCT) was a widely used theoretical framework in these interventions, as were the health behavior model, the transtheoretical model of change, and community-based participatory research approach.

Characteristics of Successful Behavioral Interventions

Interventions were considered efficacious if there were significant changes in outcomes such as child anthropometrics (BMI, BMI z-score or BMI percentile), increases in nutrition knowledge, increases in fruit and vegetable consumption, or decreases in SSB or kilocalorie intake. Interventions with significant positive results were ones that included family involvement and social support, focused on healthy changes rather than weight loss or restriction, and emphasized dietary self-efficacy.

In addition to interventions including multiple family members as targets of the intervention, many studies reported including content on strategies to improve the social support network of participants. In *Salud Con La Familia*, parents and children were placed in classes separately, followed by discussion groups consisting of 2-4 families, designed for discussion and dissemination of healthy behaviors across the cohort (65). The *Healthy Hawks* program implemented a family-based behavior group approach, a multidisciplinary approach to childhood obesity prevention focused on the active involvement of parents (66). Parents and children

attended separate classes to ensure comprehension for both educational levels, then came together for group PA. A diabetes prevention program for adolescents (ages 14-16), *Every Little Step Counts*, facilitated social interaction by inviting parents to attend classes with their children and extended the invitation to other family members as well (67). The facilitators also left time during each lesson for group discussion and encouraged participants to share their experiences in adopting healthy lifestyles. *Entre Familia* had less face-to-face contact hours, but employed the use of a *telenovela*, or Hispanic television show, to teach families about nutrition and topics related to social support (family relations, parenting styles, communication, and building social support) (68). Through personal interaction or structured lessons, many behavioral interventions were successful in their outcomes if there was additional attention given to social networks and the family, a core value in Hispanic culture.

Successful interventions promoted the idea of making healthy changes and substitutions, instead of restrictive eating for the purpose of weight loss. Dietary restriction, especially when enforced by parents, can lead to poor appetite regulation and overeating, in children given the opportunity to eat *ad libitum* (69). One of the key messages of the *Healthy Hawks* program was a “Go, Slow, Whoa” style of teaching about food groups, similar to the Stoplight Diet (70). This strategy places foods into categories that can be eaten all the time (Go), foods that can be eaten sometimes (Slow), and foods that only should be eaten on special occasions (Whoa). This strategy of teaching children about making healthier choices, not restricting their diet and listing certain foods as off-limits, which has been shown to not be effective in the long term (71). The *WeCan!* program was adapted to reflect cultural sensitivity, and also emphasized improvement of food choices (72). This program was successful in increasing nutrition knowledge and decreasing SSB consumption in their subjects. Other examples of teaching healthy substitutions

include modifying traditional Hispanic dishes with healthier substitutions, including low-fat proteins, less full-fat dairy, etc. (73). *Every Little Step Counts* taught the importance of a nutrient-dense diet for general health, not weight loss, even though this study only included adolescents with overweight or obesity (67). The principle of small changes in dietary habits and food choices is one of the key recommendation of the Academy of Nutrition and Dietetics in weight management from a recent Position Statement, due to the substantial evidence linking it to beneficial outcomes (74).

A third common theme in successful interventions is the promotion of self-efficacious behaviors in participants, in the form of goal setting, as taught in the *Healthy Hawks*, *Transformación Para Salud*, and *Entre Familia* interventions (66, 68, 75). Setting small, achievable goals promotes self-efficacy of participants, and draws from SCT, used in the majority of the included interventions. Other interventions supported self-efficacy through interactive workshops, and required participants to cook and prepare snacks, either with the children (76-78), or together as a family (65, 79). Hands-on activities promoted learning behavior and increased participants' confidence in their abilities to make healthy changes and prepare nutritious food for themselves. The *LA Sprouts*, *Transformación Para Salud*, and *Learn! Grow! Eat! Grow!* interventions also included gardening classes for children, due to strong evidence to suggest that children who have a direct experience growing food will have a greater understanding of the need for a healthy diet (75, 77, 80). This direct experience growing and producing food that they could later eat resulted in significant behavior and knowledge improvements among the children involved in these studies.

Characteristics of Unsuccessful Behavioral Interventions

Three interventions reported null results, one study only saw significant changes among the adults in the study, and another only resulted in changes among children. These studies all had aspects which likely accounted for the lack of significant results. The “Healthy Living Today” intervention, which took place in a primary care clinic, was culturally tailored by addressing barriers to healthy lifestyles specific to Hispanic families, with the goal of the intervention to address these obstacles within the family and the community (81). These null results can possibly be attributed to the lack of interaction between participants, the lack of cultural tailoring through recipes or use of a *promotora*, or that workshop content taught by the physician and dietitian was too advanced for the education levels of the participants. This intervention was also the least intensive, with only 9 contact hours over 24 weeks.

Aventuras Para Niños (APN) was a four-arm design involving either family, community, family + community (combined), or control conditions (82). The investigators hypothesized that the combined group, which received visits from *promotoras*, increased physical education in school, improved community parks, greater access to produce in schools, and education of teachers in schools, would see the most significant improvement in outcomes of interest. However, it was that the family-only condition, consisting of *promotora* visits and family involvement, produced the only observed reductions in child BMI. The community-only condition likely did not employ sufficient interaction with participants for the changes in the environment to be effectively utilized, and the combined condition was likely unsuccessful due to lack of cultural tailoring, or insufficient contact hours with the families. Another similar intervention that is still ongoing, *Niños Sanos, Familias Sanas* (NSFS), also includes combined community and family elements, by increasing physical education in school, implementing a rewards program for buying produce at the local grocery store, and regular nutrition classes for

families (79). NSFS is likely to be more successful where APN was not, due to increased hours of contact with families that are culturally tailored.

The “Familias Saludables Activas” intervention also enrolled families, but only taught lessons to parents (83, 84). During the workshops, children were taken to a separate room to play while adults learned from *promotoras*, then families would participate in PA together. A weakness of this study design, which may have contributed to null findings, was that a high level of participants that did not complete all eight workshops. While these participants were not lost to follow-up, they were not exposed to the entirety of the curriculum, however, a dose-response effect was not seen upon statistical analysis. The eight workshops were given over 12 weeks, so lack of consistent exposure may also have caused the lack of significant findings.

“Active and Healthy Families” and the “Y Living Program” were only successful in affecting either child or adult weight, respectively. “Active and Healthy Families” was designed as a family intervention, but workshops focused on the child alone (85). Before each workshop, anthropometric measurements were taken from children. Only children participated in the PA at each session. It is possible that if the program had also included content for adults, similar results would have likely occurred. The “Y Living Program” was also a family intervention, but did not include adequate resources for children (86). Children and their parents attended education classes, which were taught at the adult literacy level. Handouts and activity sheets were given to children during the lessons, but it was not enough to facilitate behavior change. This intervention also stated that it was culturally tailored, but did not specify how.

These unsuccessful interventions likely did not produce the desired results because they failed to address issues unique to Hispanics in adopting healthy changes. These interventions did not individualize the program to meet the needs and literacy levels of children and parents

separately, such as in the case of “Active and Healthy Families” (85). By facilitating inclusion of all members of the family, researchers may have been successful in modifying behaviors through family involvement. In the APN Community condition, no focus was given to the family at all; and resources were instead put into modification of the surrounding environment. The researchers in this study did not capitalize on another traditional Hispanic value, *personalismo*, or personal interaction, between researchers and participants, resulting in a null effect of the intervention. Lastly, lack of cultural tailoring resulted in null results. Including culturally-relevant foods and traditional meals can be very beneficial in making the message of health resonate with participants long after the contact hours are through.

Conclusion

Through this review of literature surrounding obesity prevention efforts in Hispanic children, it is clear that there is a need for more family-focused, culturally-sensitive interventions to prevent the further increases in obesity in this population. Characteristics of successful interventions included a combination of behavioral psychology elements entwined with Hispanic cultural values. A recent systematic review of obesity prevention and intervention interventions for Hispanic adults cited similar principles identified here (87). Elements of SCT and cultural tailoring, through recipes and types of PA, were two common elements of successful interventions. Through the use of these principles and inclusion of the whole family, interventions such as Abriendo Caminos can improve health outcomes across the lifespan. Hispanics are the fastest-growing minority group in the country, and efforts are needed to stop this worsening epidemic of obesity in these at-risk families. There are factors unique to Hispanic culture which can be capitalized upon by healthcare providers and researchers developing lessons and educational materials for these families. In addition to cultural sensitivity,

interventions need to be conducted with evidence-based nutritional recommendations and appropriate behavioral framework to maximize successful outcomes. Examination and understanding of evidence related to dietary modification for obesity prevention is key in the development of these programs. Transdisciplinary work in the fields of behavioral psychology, nutritional sciences, and family studies will result in multi-model, culturally-tailored interventions that will have greater success in promoting lasting messages of health than one-dimensional nutrition education programs.

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Chapter 3: Objectives and Specific Aims

The purpose of this research is to adapt, deliver, and assess the efficacy of the revised nutrition education curriculum of Abriendo Caminos 2 (AC2). The overall hypothesis is that the revised nutrition education curriculum will lead to improvements in nutrition-related behaviors and healthy eating patterns in families receiving the intervention, compared to the control group. The three aims of this research are described below, and presented in the following chapters, which are designed to be submitted individually as manuscripts in peer-reviewed journals.

Aim 1: Adapt the existing AC2 nutrition curriculum to reflect behavior theory, needs of the AC2 target community, and evidence-based nutrition guidelines. The original Abriendo Caminos curriculum was developed in 2006 and is inconsistent with current nutrition recommendations. In this aim, the original nutrition curriculum will be adapted based on evidence from other successful behavioral interventions for obesity prevention in children, feedback from the community, and changes in nutrition recommendations. Because AC2 is a culturally-sensitive program, the nutrition curriculum will also include culturally-relevant foods used in workshop demonstrations as well as lectures. *Working hypothesis:* In Hispanics, tailored obesity prevention programs are more successful than generalized approaches; therefore, alignment of evidence-based research with Hispanic culture and continued inclusion of families will result in effective reception of the education program by families.

The adaptations made to the AC2 nutrition curriculum, as well as the theoretical framework employed in these changes, are presented in **Chapter 4**. Changes made to the adult and child nutrition curriculum include those based on a re-examination of the behavior theory of successful nutrition interventions, input

from community partners of the Abriendo Caminos Program, and advances made in nutritional sciences research since the development of the original curriculum.

Aim 2: Evaluate the effectiveness of the AC2 curriculum through changes in healthy eating behaviors after exposure to the intervention. Because adaptations to the AC2 curriculum are based on the evidence presented in the *2015 Dietary Guidelines for Americans* (DGA), the efficacy of the program will be evaluated through an adherence index (HEI-A). The HEI-A was developed for this study to assess an individual's adherence to the 2015 DGA. In addition to HEI-A, the composition of dietary fat will be assessed through a questionnaire developed to specifically assess fat intake (MEDFICTS). Replacement of saturated for unsaturated fat in the diet was a key recommendation in the 2015 DGA and also emphasized in the adapted AC2 curriculum. *Working hypothesis:* Compared to the control group, individuals receiving the nutrition education intervention will have higher HEI-A scores and MEDFICTS scores indicative of a diet low in saturated fat at post-assessment.

The results from this study are presented in **Chapter 5**. Compared to the control group, individuals in the intervention group experienced significant increases in overall diet quality, shown by increased in HEI-A scores. There were also decreases in participants' consumption of saturated fat, as evidenced by MEDFICTS scores. For children, those in the intervention group reduced consumption of sugar-sweetened beverages and fast foods, effects that were less pronounced in the control group. The AC2 curriculum was efficacious in increasing both overall diet quality and decreasing consumption of less desirable dietary choices.

Aim 3: Assess the cardiovascular and metabolic health of participants enrolled in AC2 through a minimally-invasive health screening. Families enrolled in AC2 are sampled from the community, not a clinical setting of overweight or obese individuals. However, our baseline data from anthropometric measurements such as body mass index (BMI) indicate that the obesity prevalence in the cohort is greater than that of the general population. Though BMI is non-invasive and easy to calculate, it does not assess fat distribution or abdominal obesity, both of which are important in evaluating metabolic risk. Other markers of obesity-related comorbidities, including lipid profiles and HbA1C are also important in determining risk for dyslipidemia and diabetes, respectively. The overall objective of this aim is to assess the cardiometabolic health of the AC2 cohort through a minimally invasive health screen. *Working hypothesis:* The prevalence of obesity-related comorbidities, will be greater in the AC2 cohort than the general US population.

The results of the cardiometabolic health screen are presented in **Chapter 6**.

Overall, Hispanic females in the AC2 cohort had increased rates of dyslipidemia, specifically the low concentrations of high-density lipoprotein cholesterol, one of the defining criteria of MetS. Children in this sample had high rates of high blood pressure, likely secondary to overweight/obesity. Though the prevalence of T2DM in this sample was lower than hypothesized, many adults were at risk for prediabetes.

Chapter 4: Development of the Abriendo Caminos 2 (AC2) Nutrition Education Curriculum to Promote Healthy Choices in Children and Families: A Theory-Driven, Evidence-Based Approach

Abstract

Background Interventions seeking to prevent development of obesity in Hispanic children often involve the family unit, due to strong family support present in Hispanic families. Abriendo Caminos (AC) is a family-focused, culturally-sensitive workshop series that teaches nutrition, physical activity, and family togetherness to Hispanic families, to prevent weight gain in children. The original curriculum was developed in 2006, and was successful in modification of child dietary habits.

Objective The goal of this study is to adapt the AC curriculum to include aspects of behavior theory, community feedback and cultural tailoring, and evidence-based nutrition research, AC2.

Methods Principles of social cognitive theory, including dietary self-efficacy and behavioral capacity, were implemented in hands-on activities of workshops. Feedback from the community resulted in tailoring and addition of content. Examination of recent nutrition evidence and policy documents was conducted to refine and adapt nutrition recommendations of the workshops.

Discussion The finished AC2 curriculum is reflective of theoretical and cultural tailoring, and nutrition recommendations are in line with the current science. Since AC2 is a multi-state project, regional tailoring, specifically in food examples, will be implemented at each site. This curriculum will be delivered to Hispanic families to prevent weight gain in children through interactive and culturally-tailored nutrition education.

Introduction

Hispanic children in the United States (US) are at increased risk for obesity and experience higher obesity prevalence than those of the general US population (1). Recently, there has been an increase in the prevention of obesity in this at-risk group through modification of dietary habits and physical activity (PA) levels. Interventions that have been successful in behavior modification in Hispanic children have done so by implementing sound health behavior theoretical framework, an inclusion of cultural values, and interactive and engaging learning sessions (2-4). Most common is the inclusion of the family unit in these prevention programs. Hispanic culture places a high value on family support, and interventions which include multiple family members have been more successful than ones only targeting the individual (2, 4, 5). The integration of lessons on the various areas of family health, such as importance of family togetherness, making healthy dietary choices, and engaging in more PA has not been widely implemented in prevention programs for Hispanic families. The current study will develop and apply a culturally-sensitive and evidence-based nutrition education program involving the family unit. The goal of the *Abriendo Caminos* (AC) program is to empower children and parents to make healthy choices and be more physically active together as a family to prevent the development of childhood obesity through a scientifically and theoretically grounded workshop series.

Social Cognitive Theory

Originally proposed by Albert Bandura, social cognitive theory (SCT) revolves around the convention that observations, social interactions, and interpersonal experiences are vital in successful behavior change and knowledge acquisition (6). For behavior change to occur, an individual must observe and interact with others throughout the learning process in activities

such as behavior modeling, skill-building, and social support. Because of this, SCT is more appropriate in group settings rather than individual counseling. SCT has been applied in behavioral interventions related to a number of fields, including improvement of nutrition-related behaviors. The goal of SCT-driven interventions is to facilitate behavior change through a combination of personal and shared experiences. In nutrition education research, SCT has been used as the foundation for the development of educational interventions to facilitate dietary changes for children and adults. Examples of SCT in nutrition interventions include tasks such as menu planning, snack selection, or group cooking lessons. SCT in Hispanic families has also been widely used and has been effective in both weight loss and dietary changes (7). SCT is an effective strategy among Hispanics because of the high level of family interaction shared within Hispanic families, therefore making it an ideal atmosphere to implement elements of SCT.

A primary tenet in SCT is self-efficacy. An individual perceives his or her ability to succeed, which is directly related to the amount of energy he or she will expend to achieve set goals. If the goal is behavior change, individuals with strong self-efficacy will have greater success and will seek out new environments in which to test their abilities to stay true to their goal (6). Knowledge acquisition and mastery of required skills improves self-efficacy. Dietary self-efficacy is the degree to which people believe they are capable of identifying and selecting nutritious food choices (8). An individual with strong dietary self-efficacy will be confident that, even in an obesogenic food environment, he or she can make healthy choices. This confidence in the ability to follow a healthy eating pattern is an essential step in beginning to make and maintain changes. For children, dietary self-efficacy can be improved through skill building activities and positive reinforcement of desirable behaviors. In interventions targeting Hispanic children, dietary self-efficacy has been incorporated through activities such as gardening lessons,

in which children not only learned how to tend to a garden but were also able to make snacks and meals from the food they helped cultivate (9). In adults, dietary self-efficacy can be improved through more advanced skill building, such as interpreting a Nutrition Facts panel or planning a nutritious meal for their family (10).

Behavioral capacity, another tenet of SCT, is the continued acquisition of knowledge and skill, enhanced by content retention and skill building. Related to nutrition education, this is the ability to retain the concepts learned, and apply knowledge to make desired changes. Behavioral capacity is evaluated after the educational training is complete, through a questionnaire or formal assessment, and can be a continuous process in which developmental or educational milestones are completed before moving on to the next lesson (11). One example of this in child nutrition education is authentic assessment, in which a facilitator asks content-related questions relevant to what has just been taught (12). This allows for immediate feedback and appropriate modification of how the educational message is communicated.

SCT relies heavily on the interpersonal aspect of learning. One such aspect is social support, in which the individual perceives positive feedback from others as he or she begins to implement change. Dietary social support refers to the concept that a person's social network (family, friends, coworkers, or the instructor) will be supportive of the efforts to make improved dietary changes. Nutrition education programs that involve the family unit rely on social support, and will also teach content lessons to spouses, parents, or siblings in hopes of increasing likelihood of change because the desired message has reached a higher degree of saturation. In interventions involving Hispanics, family involvement is a strong predictor of intervention success (4, 5, 13).

Self-efficacy, behavioral capacity, and social support are fundamental principles to include in designing an education nutrition intervention to facilitate behavior change. Evidence has shown that these tenets have a synergistic effect on the eventual success of the intervention, demonstrating the complex nature of the learning process and necessity of both shared and personal experiences, paired with effective delivery of new information (8). However, behavior theory is constantly evolving, and researchers are always improving existing methods in order to modify human behavior and choice (14). Using theoretical framework to design an intervention program will only be effective if applied in the appropriate setting. Therefore, the cultural, economic, and social contexts must also be considered and integrated into the theoretical approach.

Community-Based Participatory Research and Cultural Tailoring

Community-based Participatory Research (CBPR) is the process of involving community members in the development and implementation of a health promotion intervention, such as AC2. CBPR programs rely on input from community members to share their experiences and observations regarding relevant issues in the community (15). This allows interventions to be tailored to specific problems of that community. In nutrition education programs, this may involve a pilot survey or structured focus groups to better understand the food environment and nutrition knowledge of the community. Equipped with information regarding nutritional practices of the community, researchers can create a program that will meet the needs of the community.

CBPR programs also often seek out guidance from community organizations and leaders that work with the target population on a daily basis. Schools, community centers, churches, and other volunteer organizations are common sources of community insight (16). These partnerships

provide a source of additional information regarding the goings-on of the community and potentially can be used as a recruitment tool. In the development of the adapted curriculum, the AC2 research team has reached out for the support of organizations such as local community centers and the University of Illinois Extension. These partners work with Hispanic families daily, therefore their insights are valuable in the creation of a culturally and regionally tailored product that best fit the needs of the community.

Input from community members and others who work with them can also offer insights into the cultural framework. Culturally-tailored programs for Hispanic families have proven to be more effective than programs that lack cultural tailoring (17). This is because of unique traditions and values present in Hispanic culture not found in other societies. Cultural tailoring can be done in the form of using popular foods in that community; for Hispanics this would include dishes such as rice and beans, nopales (cactus), and tortillas. Cultural tailoring can also mean inclusion of core values of that population. In Hispanics, one such value is *familismo*—the belief that the needs of the family surpass those of the individual, making interventions that involve the family more likely to be successful than ones targeting the individual (18). Additionally, the Hispanic population of the United States is very diverse, with people originating from different countries, living in different cities, and having different exposures to foods and American culture. Because of this, the cultural tailoring for a Hispanic population in rural Illinois will not be identical to a population in California, Iowa, Texas, or Puerto Rico. These five AC2 intervention sites require consideration of the unique needs in each location when developing the curriculum of AC2. The food environment, the degree of acculturation, and native traditions will all be applied to the adapted curriculum. Further, CBPR will be used as the AC2 program expands.

Evidence-Based Nutrition

In the design of nutrition education interventions, all recommendations should be evidence-based and reflect the most current state of research. The use of evidence-based practice (EBP) is a minimum standard requirement of the Academy of Nutrition and Dietetics and many other healthcare accreditation boards. Use of EBP in nutrition is the use of systematic reviews and synthesis of evidence to inform a clinician of the most successful strategy for the desired health outcome. EBP is considered best practice for making nutrition recommendations to individuals and requires nutrition professionals to stay informed of recent scientific evidence and apply it to the patient's needs. EBP is built on robust scientific evidence, clinical experience, and the idea that science is dynamic (19). As nutrition research progresses and the role of food and nutritional status in health and disease is better understood, previous recommendations may change or be debunked. Alignment of the AC2 curriculum with recent scientific evidence ensures that participants are taught the most accurate and effective strategies to improve their dietary habits and prevent excessive weight gain within the family.

The *Dietary Guidelines for Americans* (DGA) are a policy document released every five years by the US Department of Agriculture (USDA) and the Department of Health and Human Services, and serve to inform federal nutrition programs, policymakers, and health professionals of the current state of evidence surrounding the components of a healthy diet for Americans (20). The guidelines are developed through an extensive review of recent scientific evidence regarding diet and dietary components, large-scale analysis of food patterns consumed in the US, and consultation of an expert panel. The advisory committee conducts evidence-based reviews and evaluates the preponderance of the science to prepare a set of recommendations, from which federal policy is established. The guidelines are implemented in the design of school food

offerings, federal nutrition assistance programs, and transmission of dietary approaches to consumers via clinicians. This final step also relies heavily on the Social Ecological Model, which posits that support for behavior change from multiple levels, such as the country, community, and family, will result in greater success than support from one level alone (21).

AC2 seeks to integrate multiple levels of support through the use of federal nutrition recommendations put forth in the DGA, community input, and family involvement to increase the likelihood of successful dietary changes and prevention of excess weight gain in Hispanic families. The goal of AC2 is to prevent the development of childhood obesity by promoting healthy changes, namely diet and PA, through strong familial support and inclusion of beneficial aspects of the traditional Hispanic diet.

Methods

Curriculum Development

The original AC curriculum was developed in 2006 by researchers at the University of Illinois at Urbana-Champaign and is described elsewhere (22). Hispanic families were enrolled in a 6-week, two-hour workshop program on the topics of nutrition, family mealtimes, and PA. The theoretical framework of the curriculum was centered on SCT, family resiliency theory, and cross-cultural psychology. The aim of the present study is to adapt and expand the AC program into a multi-site, randomized control trial – AC2. After investigation of applied behavior theory in community nutrition programs, several adaptations were made to the AC nutrition curriculum to be used in AC2 (**Table 4.1**).

Research Design

AC2 is a randomized-control trial intervention in which participants, consisting of one parent and one child between the ages 6 to 18 years randomized to either the intervention or control

condition. Families in the intervention condition were enrolled in a six-week workshop series on topics relating to nutrition, PA, and improved family functioning. The abbreviated-attention control group received three, bi-weekly workshops on topics unrelated to health.

Intervention

The goal of the AC2 nutrition curriculum was to encourage healthy dietary and lifestyle changes in Hispanic families through interactive education. Families were engaged in discussions, games, taste tests, and food demonstrations to facilitate learning through the integration of multiple senses and styles. Because of the social nature of Hispanic culture, activities were completed either as a group or within families. The weekly topics, learning objectives, food demonstrations, and take-home educational materials are presented in **Table 4.2**.

Interactive Activities and Hispanic Food Demonstrations

Children and adults were separated for nutrition lessons, and children received a simplified version of the content with more time for interactive activities. This separation allowed for nutrition lessons to be tailored to each group and allow adults to learn at a higher level and free from distractions. Each lecture began with a brief recap of last week's topic, followed by an introduction of the current day's topic and learning objectives. Adults were given educational materials and kitchen equipment to use at home. Each lesson for children was accompanied by a hands-on food demonstration or interactive game in which children were informally assessed on their understanding of lesson content. These authentic assessments have been used in nutrition education programs for children to immediately evaluate if the message has been received and understood (12). In workshops, if children incorrectly answered questions

or had difficulties, the facilitator would repeat and rephrase content for better understanding. Weekly activities and food demonstrations are outlined here.

In Week 1, children were taught about various food groups and how to identify correct serving sizes for each group. The workshop content is centered on MyPlate, a tool created by the USDA to depict the recommended proportions of fruits, vegetables, protein, grains, and dairy on a plate for a healthy diet. After the content portion of the lesson, children were able to make a Portion Plate to take home and share with their family. Adults also learned about correct portion sizes for both themselves and their children. When families were brought back together, they were offered cheese quesadillas made with either flour or corn tortillas, and the facilitator explained that because a flour tortilla is larger and higher in calories than a corn tortilla, participants could eat one serving size of either half of a flour tortilla or one whole corn tortilla. Participants were able to serve themselves, and practiced choosing appropriate portions.

The topic of Week 2 was fruits and vegetables. After the lesson, children were presented with several types of fruit to make fruit kabob snacks. Children practiced appropriate portion sizes and chose from a variety of fruits. All participants were offered a display of shredded vegetables common in the traditional Hispanic diet: carrots, beets, and jicama. Vegetables were prepared with lime juice and a traditional Mexican seasoning. As in Week 1, participants served themselves and practiced choosing appropriate portion sizes. The goal of this demonstration was to show a culturally-relevant, nutrient-dense snack that could be enjoyed by both children and adults. The recipe for this dish was provided to adults so they could make it at home.

After the “Choosing Más Whole Grains” lesson during Week 3, children were shown a series of pictures and asked if the food is whole or refined grains. If the food was refined grain,

the facilitator would teach children how that food could be replaced for whole grains. Again, this served as an immediate assessment of children's understanding of the lesson. Children and adults were shown how to make a culturally-tailored popcorn recipe, served with small amounts of low-fat Mexican cheese and seasoning. Participants served themselves after the facilitator explained what an appropriate serving size was and how it counted towards daily whole grain recommendation. Similar to the shredded vegetables, parents were given the popcorn recipe. Families were also given sugar skulls. These are commonly eaten around "Día de Los Muertos" in Mexico but are traditionally made with from either a sugar or amaranth base. The skulls made during AC2 were made with amaranth, a whole grain, to promote healthier substitutions of cultural recipes.

During the Salt and Sugar lesson of Week 4, children played a game requiring them to guess the sugar content, in tablespoons, of different foods and beverages. Foods included carrots, yogurt, lemonade, desserts, and soda. After identifying the sugar content, a short discussion took place regarding the difference between sugar occurring naturally in foods such as fruits and vegetables, and sugar added to certain foods.

The last week of educational material (Week 5) covered fats and proteins. After the lesson, children and adults tasted different types of milk and cheese (non-fat, low-fat, and full-fat). Participants were blinded to which type of cheese/milk is which and asked to guess which has the highest fat content. The goal of this taste test was to distinguish between different types of dairy and choose low-fat options when possible.

The final week of AC2 was the Fiesta. The goal of this week was to integrate and apply knowledge about nutrition and healthy choices as a family. Families were encouraged to bring a traditional dish their family enjoys to share at the Fiesta. Children and parents were encouraged

to work together to apply the lessons of the previous five weeks to make their dish healthier. Some examples were: using Greek yogurt instead of sour cream; replacing regular cheese for low-fat; or choosing leaner meats. At the fiesta, families presented their modified dishes. The integration of traditions, cultural dishes, and interactive workshops created a dynamic environment in which participants could learn through both listening and learning while allowing for alignment of healthy eating with families' roots in Hispanic culture.

Workshop Content

The concept of *más o menos* was integrated into all the lessons, in order to focus on small changes or substitutions for healthier lifestyles. Children were taught on the first day the importance of healthy eating not for weight loss or appearances, but for overall health. The lecture included photos of a family playing soccer together, while the facilitator explained the importance of fueling their bodies with healthy foods to provide energy for sports and activities. Parents were taught that they can be strong role models for health-related behaviors. This was also integrated into examples of foods, similar to the Stoplight Diet and “Go, Slow, Whoa” food lists (13, 23). For example, in the grains group, a *más* food is a corn tortilla, a food that can be consumed all the time. A *más o menos* food, which is a food that could be eaten often but not every day, is a flour tortilla. And finally, a *menos* food is one that should only be consumed occasionally, such as a muffin.

In Week 1, food groups were introduced, and recommended number of serving sizes were given both for the day and as a goal to reach for every meal. For children, the concept of portion sizes was explained through the creation of the Portion Plate, and the “Handy Portion Guide” exercise and take-home handout. The facilitator explained to children how to use their hands to model proper portion sizes for proteins, grains, fruits, vegetables, and fats. The Handy

Portion Guide is available in **Appendix B**. At the beginning of each lesson, the MyPlate graphic was shown and the facilitator introduced all food groups represented to all participants, as these reflect the AC2 lessons. Other resources available on the MyPlate website were also used, such as coloring sheets for children. The facilitator also reviewed the previous week's topic, and asked children about the different objects on the Plate and what they represent, and how many servings of that food group are needed a day. Children were praised and rewarded with stickers if they answered questions right. Content repetition was done throughout the lesson. The facilitator would occasionally stop and ask participants to repeat back content or ask questions about what had been learned.

In Week 2, participants learned about fruits and vegetables, the importance of consuming adequate numbers of servings from various subgroups, and which subgroups are high in certain vitamins and minerals. The lecture also taught the differences between organic and conventional foods and the importance of proper food safety. Mothers were encouraged to buy frozen vegetables and taught that there are no nutritional differences between fresh and frozen vegetables. For canned fruits and vegetables, both mothers and children were shown Nutrition Facts labels and instructed to be aware of sodium and sugar content of canned produce, as these may be added during canning as preservatives.

The lesson for Week 3 taught participants about consuming *más* whole grains. In this lesson, participants learned what a whole grain is, why consumption of whole grains is beneficial to health, and how to identify whole and refined grains. The adult nutrition lesson also included additional information about fiber from whole grains.

The lesson covered in week 4, Sugars and Salt, discussed why these dietary components should be consumed less frequently. Sugar and salt were presented as *menos* foods, and the

facilitator explained the health consequences of overconsumption of these two nutrients. Sugar-sweetened beverage (SSB) consumption was addressed.

Fats and proteins was covered in Week 5. The purpose of this lesson was to teach about different sources of fat in the diet, and how to choose healthier options. Participants learned ways to replace saturated for unsaturated fat in the diet, and why this is beneficial to health. Lecture content included the different types of fat, described as fats from animal sources versus fats from vegetable or plant sources. Examples of fats from animal sources included beef and pork. These were described as *menos* foods, especially choices high in saturated fat or foods that have been fried. Fats from plant sources are foods such as nuts and nut butters, oils, and avocados. These were explained as *más* foods, with the exception of tropical oils, which are high in saturated fat. The adult lesson also emphasized the differences between dietary and serum cholesterol and distinguished between high-density and low-density lipoprotein cholesterol. Dietary fat was explained as a necessary macronutrient, and consequences of consuming too little or too much dietary fat were addressed.

Discussion

The AC curriculum was adapted to integrate applied behavior theory, cultural and community feedback, and evidence-based nutritional science. Previous family-focused education programs were examined for the theoretical framework, which was applied to the AC2 curriculum in addition to consideration of Hispanic culture, including recipes, holidays, and traditions. These adaptations also relied on input from community members and external partners. As AC2 is a multi-state project, the culture and dietary practices of Hispanics at each site were considered and tailored to the specific site as needed. Workshop content was added or adapted to reflect the latest research in nutrition. Adaptations were made for one of three reasons:

application of behavior theory; input from community partners; or advances in nutrition research. The finished product (AC2) is a theory-driven and evidence-based workshop with the overall goal of improving family health through a series of manageable changes aligned with traditional Hispanic culture.

Theory-Based Adaptations

The recurrent use of *más o menos* was done to avoid teaching dietary restriction, emphasizing that a healthy diet includes increased consumption of nutrient-rich foods such as fruits and vegetables, and occasional consumption of high-calorie, low-nutrient-dense foods such as candy or desserts. Avoidance of restrictive eating has become common practice in nutrition counseling, as it is associated with higher prevalence of disordered eating in adults and adolescents. In Hispanic children, restrictive eating behaviors imposed by parents were associated with higher child BMI, indicating that this group may be at increased risk for adverse effects of disordered eating practices (24). As mentioned in the methods section, the *más o menos* tool is similar to the Stoplight Diet. The Stoplight Diet was also taught with information about how to complete a food diary, and limits on how many red, orange, or yellow foods to eat in a day or a week. AC2 did not employ all aspects of the Stoplight Diet but did incorporate concepts into lectures and take-home materials. The Stoplight Diet was given an evidence grade of I (Strong) by the Academy of Nutrition and Dietetics to be effective in teaching healthy eating habits and weight management for both children and their parents (25).

The concept of eating well for health, not weight loss, has been well received and repeated in many successful interventions targeting Hispanic families (5, 13, 26, 27). Parental influence over child diet is also emphasized, as Santiago-Torres et al. observed that Hispanic children were more likely to consume fruits and vegetables if they observe their parents

consuming these foods (28). This is indicative that in this population, parents are strong role models for health-related behaviors.

Though SCT was part of the original framework, additional aspects have been integrated into the Child Nutrition curriculum. In the original curriculum, children were required to bring the Portion Plates that they had created for each week's lesson. Instead, a brief review of MyPlate replaced this at the beginning of each week. This removes any negative feelings children may have if they forget their Portion Plate and allows for positive reinforcement of different food groups on the plate. Consistent reinforcement of learned topics is a key tenet of SCT, and has been used in nutrition education curricula and found to be successful in changing behaviors (29). Content repetition was among the adapted material, to make lectures more engaging for children and increase their behavioral capacity. Performance feedback has also been used in interventions to assure the program messages are being delivered as intended (30). Through a sound understanding of the nutrition content, the child can become more confident in knowing how to make healthy changes (12). Self-efficacy, another tenet of SCT, was integrated into the child curriculum through hands-on activities that will allow for application of learned concepts. Activities in which participants serve themselves food were intended to increase skill building and strengthen dietary self-efficacy, allowing them to believe they will have success in making healthy choices in the future (31).

Adaptations due to Community Feedback

Because AC2 seeks to reflect the culture of the community it serves, input from community members was considered in adaptation of the curriculum. The Hispanic population is particularly heterogeneous, so effective cultural tailoring should vary depending on the target population's place of origin, community, and individual socioeconomic factors. To integrate

feedback from the community CBPR has been an efficacious approach to obesity prevention in Hispanic communities (32). For the adaptation of the AC2 curriculum, this was done through structured focus groups, through observational notes taken by facilitators during the first cycle of workshops, and through early program feedback from University of Illinois Extension staff.

Focus groups were conducted in order to uncover barriers that Hispanic mothers face in adopting better health practices for themselves and their families. Thematic coding analysis from focus group transcriptions was completed. Data resulting in direct adaptations to the curriculum are presented in **Table 4.3**. One such barrier among mothers at the Illinois site was a lack of knowledge regarding portion sizes. One mother reported at one meal, each member of the family would eat around six tortillas, three times the recommended portion size for corn tortillas, and six times the recommended portion for flour tortillas (33). Information about nutrition knowledge of the community led to the incorporation of a portion size demonstration in Week 1's lesson, as described above, and the Handy Portion Guide for children (**Appendix B**). Another adaptation made after the Illinois focus groups was inclusion of content about the nutritional differences between fresh, frozen, and canned fruits and vegetables, after mothers expressed the lack of financial resources to buy fresh produce for their family, but felt as though they were “bad moms” if they served their children vegetables that had been frozen or canned. Other feedback came from observational notes taken by research staff during workshops. One participant mentioned that she did not buy any produce for her family because she could not afford organic or non-genetically modified organisms (GMO) produce, and that conventional produce was “not as healthy as the organic or non-GMO foods”. From this, content about differences between organic, non-GMO, and conventionally grown foods was added to the adult lecture. It was also explained that there is no existing evidence that organic or non-GMO foods

are nutritionally superior (34). Parents and children were also instructed on proper food washing techniques, adapted from the Fight Bac! ® Initiative. Focus groups will be conducted in the AC2 partner sites in California, Iowa, Texas, and Puerto Rico. If needed, regional adaptations will be made to the curriculum for that specific site.

One of the goals of the AC program is to create a series of educational materials that can be disseminated to be used by lay members of the community or Extension programs to continue to promote family health in nutrition. When adapting and creating education materials, input from members of the University of Illinois Extension was sought to ensure that materials would be well received by individuals without a nutrition background. This review was valuable in the development of content lessons. One such change that was made was in the presentation of the recommended number of servings from different food groups recommended for children and adults, from servings per day to also include recommendations presented as goals to meet at each meal, assuming three meals a day. By translating recommendations, for example from six ounces of grains per day, to two ounces at each meal, participants will understand these food groups and portion recommendations as the foundations for a meal, and make use of the MyPlate tool.

As part of the review process for the adapted curriculum, Extension was also consulted on feasibility and applicability of food demonstrations and recipes that would be implemented in workshops and given to families to try at home. In AC, Week 5's Taste Test involved participants tasting cookies made with butter versus cookies made with applesauce. After discussion, the research team concluded that though cookies made with applesauce are a healthier substitution, AC2 should seek to promote healthy choices from whole foods, and that this exercise would still be useful if milk and cheese were used. Though there is conflicting evidence between the consumption of full-fat or low-fat dairy products for obesity-related

disease prevention, the 2015 DGA still recommend non-fat or low-fat dairy consumption, so low-fat choices will be encouraged during the intervention over the full-fat options.

Adaptations to Reflect Evidence-Based Nutrition

The goal of AC2 is to improve nutrition and PA in families through evidence-based nutrition education. The AC curriculum was developed in 2006, and there have been several notable changes in the state of nutrition evidence for obesity prevention between 2006 and 2015, and thus, many recommendations and lessons had to be adapted. As with other adaptations, Hispanic culture was also considered when adding content topics. For example, Hispanic children have some of the highest consumption rates of sugar-sweetened beverages (SSB) in the US, so Week 5, “Sugar and Salt” had specific emphasis on SSB intake and why it is adverse to health (35).

The 2015 DGA were the primary source for many of the evidence-based changes made to the new curriculum, to ensure that the messages given in AC2 workshops will be in line with federal nutrition recommendations (20). Changes between the 2005 and 2015 DGA include the incorporation of MyPlate, removal of the recommended upper limit for cholesterol intake, and additional discussion of the importance of healthy eating across the lifespan. Additionally, content changes were made to include strategies for healthy eating and obesity prevention that were published in top peer-reviewed journals or systematic reviews from the Evidence Analysis Library (EAL), published by the Academy of Nutrition and Dietetics. The EAL is used by nutrition professionals for evidence-based recommendations on a variety of topics, including weight management for both children and adults.

MyPlate is a graphic that was introduced in the 2010 DGA (36), replacing the previous MyPyramid. MyPlate includes five major food groups on a circular plate, representing the proportion of each on an ideal plate for a healthy diet. MyPlate was chosen to replace the food pyramid in June 2011 and is an easily recognizable symbol that is also more easily understood and implemented than the food pyramid (37). MyPlate is used in AC2 instead of “El Plato del Buen Comer” (**Figure 4.1**). This graphic represents the dietary guidelines used in Mexico, which like the DGA, are updated every five years. El Plato was last updated in 2010. This graphic has three main food groups, each filling one-third of the plate: fruits & vegetables, cereals (grains), and legumes & animal proteins. The Mexican dietary guidelines share similar recommendations to the DGA, including the consumption of whole grains, limiting SSB, and reducing sodium intake from processed foods (38). However, unlike the DGA, there are not detailed recommendations for types of fat consumption or eating a variety of nutrient-rich foods. The move to use MyPlate instead of El Plato was done to both reflect current federal recommendations, and because families may also be exposed to MyPlate graphics in places outside the AC2 intervention.

Several adaptations were also made to the lesson on fats and proteins (Week 5) based on recent evidence. In AC1, participants were advised to avoid foods high in cholesterol, such as eggs and red meat. These were called “bad fats”, and “good fats” were foods such as olive oil, fish, and other sources of unsaturated fat. The previous limit on dietary cholesterol was removed in the 2015 DGA, after further review of the evidence surrounding dietary cholesterol intake and cardiovascular disease risk, and it was determined that there was not sufficient evidence linking cholesterol intake and serum cholesterol levels (39). The discussion on “good” and “bad” fats was also modified, due to the integration of a non-restrictive (*más o menos*) approach to dietary

changes. In the original curriculum, one of the lecture slides was entitled, “Why Fat is Bad” for both adult and child lectures. This was changed to read, “Why *Too Much* Fat is Bad.” Dietary fat is an essential macronutrient, used in the formation of cell membranes, absorption of fat-soluble vitamins, and necessary for proper functioning of many systems in the body. This revision was done to remove the stigma of dietary fat as unhealthy. However, dietary fat is the most calorically-dense of all the macronutrients, providing 9 kilocalories per gram, and overconsumption can lead to positive energy balance and weight gain. Replacement of saturated fat with unsaturated fat, in the form of mono- and polyunsaturated fat, is one of the key recommendations of the 2015 DGA. This replacement has been shown through clinical trials and meta-analyses to reduce the risk of cardiovascular disease and type 2 diabetes mellitus (T2DM) in adults (40, 41). Additionally, limiting of saturated fat intake is recommended by the American Heart Association to prevent obesity and risk of cardiovascular disease in children (42).

Additional content was added to the whole grains lesson (Week 3) to define and discuss the benefits of dietary fiber. Dietary fiber, which is found in whole grains, fruits, and legumes, has been implicated in improving weight management and obesity-related comorbidities, specifically T2DM (43, 44). However, the average intake of fiber in the US is less than half the recommended intake levels. Average intake is around 16 grams/day, compared to the recommendation of 25 grams/day for women and 38 grams/day for men (20), in part due to the high consumption of refined grains in the US. The 2015 DGA recommend at least half of daily grains to come from whole grain sources, but Americans across all ethnicities are falling below this recommendation. There is also moderate evidence linking whole grain consumption to reductions in body weight (45). Because of the current state of fiber consumption and its health

benefits, the curriculum was adapted to include additional lecture slides and take-home education material for parents regarding fiber.

Strengths and Limitations of AC2

The AC2 curriculum integrated nutrition education with family interactions to modify dietary habits and prevent excessive weight gain in children. The primary objective was prevention of weight gain in children enrolled in the intervention, in order to prevent development of obesity and its related complications. In addition, the program served to educate parents about their role as influencers of their child's diet. A strength of the AC2 protocol was the strong behavioral and nutritional science in which it is grounded. The AC2 protocol employs theory-driven strategies to increase dietary self-efficacy and behavioral capacity in both children and adults exposed to the program. Examination of previous literature and scientific evidence allowed for AC2 to promote accurate, effective nutrition education strategies for childhood obesity prevention. An additional strength was the involvement of external partners for curriculum review. The individual at University of Illinois Extension who reviewed the curriculum is a registered dietitian nutritionist and was able to provide feedback on both clarity of the lessons and the content recommendations and accuracy of information. The research team was comprised of many professionals from different professional, cultural, and educational backgrounds, who all provided feedback and assistance in the development of the finished product. This transdisciplinary team ensured that the lessons could be understood and taught by people without a nutritional or scientific background.

The continued adaptation of the AC2 curriculum allows for the intervention to meet the unique needs of the participants at each intervention site. The curriculum will be modified to meet the needs of the target population, resulting a more personalized approach to nutrition

education. However, because there are five partner sites, and each site expected to make regional adaptations to the curriculum based on structured focus groups and observational notes, extra caution is needed to be taken to guarantee program fidelity between sites. There will be regular communication between program sites, and all changes will be properly documented. To further ensure program fidelity, research team members from Illinois will travel to the other partner sites, to provide formal instruction for delivery of the curriculum, and insurance that survey and anthropometrics data are also being correctly collected. Comparisons will also be made between intervention sites, to assess a potential regional effect on adoption of healthy behaviors. One of the long-term goals of the AC2 program is to create materials that can be disseminated to the public and widely used and adapted for people of different regional and educational backgrounds. By cementing the nutritional content and behavioral theory which forms the central core of the curriculum, minor changes such as types of foods used for examples will allow for the messages to be more clearly understood by diverse groups.

Conclusion

Nutrition education programs will be more successful in behavior change if the curriculum is tailored to the participants' cultural, regional, and community background. The adaptations made to the AC curriculum reflect the identity of the community in which the intervention will serve. These adaptations are a continuous process, and there will be further cultural and regional adaptations as the partner sites in Iowa, Puerto Rico, and Texas conduct focus groups and learn more about the Hispanic population living in their target area.

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Tables and Figure

Table 4.1. Theory-based adaptations to the Abriendo Caminos Curriculum

Adaptation	Behavior Theory Construct
Lecture content for adults regarding their role as influencers and role models for children by eating more nutrient-rich foods in the house	Modeling behavior can allow for children to learn through observation of their parents
Children will be able to make their own fruit kabobs from bowls of fruit and practice appropriate portion sizes	Skill-building activities aimed at improving children's self-efficacy in making healthy choices
Facilitator will review MyPlate food groups every week with the children	Weekly reinforcement of knowledge to improve children's dietary self-efficacy
At the beginning of each lesson, the facilitator will review content from last week, and ask questions about the topic they had previously covered	Content-related questions will improve children's behavioral capacity and improve knowledge retention.
During the "Whole versus Refined Grain Guessing Game", if an answer is not correct, the facilitator will review that specific concept with the children	This immediate performance feedback also allows the facilitator to know if messages are being understood and accepted
The first lecture for both adults and children will cover the importance of a nutrient-rich diet not for weight loss, but for health.	A focus on healthy eating for overall health, not weight, has been used previous obesity prevention and treatment programs

Table 4.2. Summary of the Abriendo Caminos Nutrition Curriculum

Week	Lesson	Objectives	Activity	Take home materials
1	Portion Sizes Water	1. Understand why healthy eating is important 2. Learn proper portion sizes for food groups 3. Learn the importance of drinking adequate water	Create a portion plate (kids) Quesadilla portion exercise	“Rethink Your Drink” “Small Changes Can Make a Large Difference” Measuring cups and spoons
2	Fruits & Vegetables	1. Reinforce portion sizes from last week 2. Review daily recommendations for fruits and vegetables 3. Learn benefits of different fruits and vegetables	Fruit kabobs (kids) Shredded vegetables with lime and seasoning	“What’s in Season” “Saving Money at the Grocery Store” “ <i>Más o menos</i> When You’re Short on Time” Fruit and vegetable cards
3	Whole Grains	1. Reinforce lessons learned so far 2. Understand what whole grains are and why they are important 3. Distinguish whole grains from refined	Amaranth skulls Whole vs refined grain guessing game Mexicali Popcorn	“Reading a Nutrition Label for Carbs” “All About Legumes” “Fiber Facts”
4	Salts & Sugars	1. Identify foods that are high in salt and sugar 2. Learn ways to limit sugar and salt in the diet 3. Understand why consuming excess salt and sugar is detrimental to health	Demonstrations of salt and sugar content of popular foods Guessing game of sugar content	“Tips for Using a Nutrition Facts Label”
5	Fats & Proteins	1. Identify lean sources of protein 2. List the differences between saturated and unsaturated fat 3. Learn how to exchange saturated for unsaturated fat in the diet	Taste test: skim, 2%, whole milk; fat free, skim, regular cheese	“Preparing Your Proteins” “Go, Slow, Whoa” “ <i>Más o menos</i> at the Grocery Store”
6	Wrap-up/Fiesta	1. Integrate knowledge from previous weeks 2. Apply knowledge to creating a healthy versions of a traditional recipe	Family will make and bring a healthy version of a family recipe	Certificate of completion

Table 4.3. Representative Focus Group Quotes Resulting in Curriculum Changes

Participant Quote	Resulting Change
"Honestly, we are used to a mountain of rice and a mountain of meat and until you are done"	Addition of Handy Portion Guide handout and further discussion of appropriate portion sizes
"The flavor is different. And I feel that also it is different like, the nutrition, different here in that the food and how they are produced, we say, the products like they produce in your country. They are fresher, meats are newly, well yeah, newly fresh. But not here, they're iced or the vegetables that have a lot of chemicals"	Addition of content about differences between organic and conventionally farmed foods
"One goes [to the farmer's market] and it's richer [better quality] and fresher, but it's more expensive. It's not that I don't want to cook healthier"	
"When we have an emergency, well I use canned beans but they're not very nutritious"	Lecture content about the nutritional differences and similarities between frozen or canned produce and fresh
"Well, look once I went to a talk at the University and they talked about nutrition and it wasn't the same to buy canned vegetables as fresh, that we take only liquids that are conserved, same with fruit."	



Figure 4.1. “El Plato del Buen Comer”. Source: *fao.org*

Chapter 5: Adoption of a Healthy Eating Pattern after Exposure to a Nutrition Education Curriculum

Abstract

Background Hispanics have high consumption of energy-dense, nutrient poor foods such as sugar-sweetened beverages (SSB), and foods high in saturated fat (SFA). These habits contribute to increased obesity, and intervention efforts should seek to modify these behaviors.

Objective To assess changes in dietary habits among mothers and children enrolled in a family-focused, culturally-sensitive nutrition education program to prevent obesity in Hispanic children.

Methods Data were collected at baseline (T0) and post-intervention (T1), and semi-quantitative food frequency questionnaires were used to assess mother and child diets. Mother-child dyads were randomized to receive a six-week nutrition education program or a control condition. Mother's diet was assessed through adherence to the *2015 Dietary Guidelines for Americans* (HEI-A), and child diet was reported as weekly consumption of various food groups. Statistical significance was determined by student's t tests for intervention effects.

Results Thirty-six dyads (17 intervention/19 control) completed the program. Among mothers in the intervention, HEI-A scores significantly increased from 41.7 ± 15.8 to 66.1 ± 13.5 ($P=0.004$). There were significant increases in the individual components of consumptions of lean proteins, and fruits and vegetables. SSB consumption among children in the intervention decreased significantly from 6.7 (95% CI: 2.5-10.8) times per week to 2.7 (95% CI: 1.1-4.2, $P=0.03$).

Conclusion Participants enrolled in the AC2 workshop intervention reported improved diet quality, both overall and specifically in areas commonly overconsumed in Hispanics.

Introduction

The United States (US) has seen an increased prevalence of overweight and obesity in the past 30 years, partially attributed to increased consumption of energy-dense, nutrient poor foods (1). Though consumption of these foods, in the form of solid fats and added sugars, has decreased over the past ten years, intakes are still higher than recommended (2). Nutrient-dense foods such as fruits, vegetables, and whole grains are still under-consumed in both adults and children. Overall diet quality, assessed by tools such as the Healthy Eating Index (HEI), allows for a comprehensive assessment of multiple macro- and micronutrient intakes from whole food sources (3). Analysis of diet quality of the National Health and Nutrition Examination Survey (NHANES) cohort, expressed by the HEI-2005, revealed that overall diet quality of US citizen is not ideal, with a mean score of 56 out of 100 for all adults and children in this large sample size (4).

This epidemiologic study by Hiza et al. also reported significant differences between ethnic groups in both total score, and the twelve dietary components that contribute to the summative score (4). It was found that Hispanics had highest overall diet quality, mainly due to their high scores in three of the nine Dietary Adequacy Components of whole fruit, total vegetables, and legumes. However, Hispanics also had the highest reported intakes of Dietary Moderation Components including saturated fat (SFA), sodium, and calories from SoFAAs (Solid fats, Alcohol, and Added Sugars). Though the NHANES cohort is representative of the US population, it does not distinguish between Hispanic subgroups. Another large-scale epidemiological study examined diet quality between subgroups in the Study of Latinos (SOL) cohort (5). This study concluded that Mexican-Americans had the highest diet quality overall, but also high intakes of the same moderation components found by Hiza et al. Puerto Ricans

were found to have the lowest diet quality scores, and the lowest mean intakes of both fruits and vegetables. When developing nutrition education or intervention programs for diverse populations, it is imperative for nutrition professionals to understand not only overall dietary habits, but also the specific areas that need improvement, to allow for development of tailored educational messages. When working with Hispanic populations, devoting more time directly addressing the aspects of the diet that have been found to need the most improvement, SFA and added sugars, may have greater success in changing these individual components than a generalized approach.

The objective of this study was to assess diet quality in a population of Mexican-American and Puerto Rican families before and after a culturally-tailored nutrition education program, *Abriendo Caminos* (AC2). AC2 is a randomized control trial that was developed for the prevention of childhood obesity, and the nutrition education aspect of the curriculum focuses on development of healthy eating patterns, and has additional content about decreasing consumption of SFA, added sugars, and sodium. The hypothesis was that scores of overall diet quality and the categories in which specific emphasis was given would increase after exposure to the AC2 curriculum.

Methods

Participants and Intervention

Parent-child dyads of Mexican or Puerto Rican descent were recruited from the community as part of AC2, a multi-site, five-year program. Recruitment was done through flyers placed in the community and through research staff actively recruiting eligible families. Only participants at one intervention site are included in this analysis. After informed consent had

been obtained, participants completed baseline data collection measures, and were then randomized to either the control or intervention condition. Randomization was done through selection of either a green or yellow colored ball by the participants; participants were not matched at baseline.

Families in the intervention condition took part in a six-week workshop series, conducted at either the University of Illinois or at community centers in the evenings. The workshops were two hours in length, and consisted of 30 minutes of nutrition education (children and adults were taught separately), 30 minutes of family functioning, and one hour of physical activity (PA) in the form of dancing videos or bodyweight strength exercises. Nutrition topics include lessons on portion sizes, fruits and vegetables, whole grains, fats, and proteins. Many nutrition lessons were presented to match recommendations published in the *2015-2020 Dietary Guidelines for Americans* (DGA) (6). An abbreviated-attention control group was implemented, in which the control group received workshops on topics unrelated to family health. The Institutional Review Board of the University of Illinois at Urbana-Champaign approved all study procedures.

Measures

Surveys were administered in the participant's language of choice (Spanish or English) at baseline (T0) and six-weeks post intervention (T1). Translations of measures were acquired from the original source, or translated and back-translated by a team of native and non-native Spanish speakers. The survey was then pilot tested for clarity and completion time. Participants could complete the survey via structured interview, in which the questions were read aloud by a researcher. Assessments of diet quality were used to assess mother and child diet. Diet was assessed over both the previous month and the previous week. To assess diet over the past month, the Rapid Eating Assessment for Patients (REAP) and Rate Your Plate (RYP) dietary

assessment tools were used (7, 8). The REAP and RYP tools have been validated in Spanish, and are widely used to quickly yet accurately assess the overall diet quality of an individual. The RYP replaced the REAP because it covers all aspects of diet, with increased attention to “heart healthy” choices including whole grains and low-fat choices (9). Diet quality over the past week were assessed by the Meat, Eggs, Dairy, Frying foods, fat In baked goods, Convenience foods, Table fats, and Snacks (MEDFICTS). The MEDFICTS was initially developed to assess adherence to the dietary fat recommendations of the American Heart Association (10). Responses are summed to a final score that is indicative of a healthy diet low in SFA, or one consisting of SFA intakes that exceed recommendations. The scoring categories are as follows: <40 points = adherence with the 2013 AHA Lifestyle Guidelines (<7% of calories coming from SFA); 40-70 points = “Heart Healthy Diet” (7-10% total calories from SFA – in accordance with the 2015 DGA), >70 points = consuming a diet high in unhealthy choices. The MEDFICTS also has been validated in Spanish (11). The Family Diet Behavior Questionnaire (FDBQ) was used to assess child diet via parent-report. The FDBQ was adapted from the Latino Dietary Behaviors Questionnaire, and was used both in the *Abriendo Caminos* pilot study, and the Study of Latinos (SOL) (12). The following food groups were asked: milk, sugar-sweetened beverages (SSB), whole fruit, 100% fruit juice, fried food, vegetables, fast food, sweets, and salty snacks. The response options are on a 1-7 Likert scale ranging from never consume to consume four or more times a day. These assessments were chosen over a more precise measure of dietary data collection (i.e. 24-hour dietary recall or food logs) because all measures were given as part of the AC2 survey, which included constructs not related to nutrition.

Diet Assessment

In order to assess adherence to the 2015 DGA, we propose a Healthy Eating Index for Adherence (HEI-A). This index takes into account key recommendations from the 2015 DGA (6). The index developed is similar to the 2010-HEI, but there are some differences (**Table 5.1**). The index is similar to the HEI-2010 in that there are ten components corresponding to recommendations of the DGA. Questions from the REAP and RYP that correspond with these recommendations were summed to create an individual score (0-10) for that category. The overall HEI-A score (0-100) was a composite of the ten individual scores. Higher scores reflect higher adherence to the key recommendations of the DGA, where lower scores reflect lower adherence and poor diet quality.

Anthropometric Data Collection

Height and weight were measured by Seca stadiometers and scales, respectively (Seca North America, CA, USA). Each measurement was taken twice by formally trained research staff, and the average of the two measurements was recorded. Body Mass Index (BMI) was calculated by kg/m^2 , and overweight and obesity were diagnosed by the Centers for Disease Control and Prevention (CDC) BMI charts for adults, and by BMI percentile in children was calculated using age-and-sex specific CDC growth charts.

Statistical Analysis

Only participants with complete data at T0 and T1 were included in this analysis. Normality was determined by Kolmogorov-Smirnov tests, skewness, and kurtosis, and non-normally distributed variables were log transformed prior to determination of significance. After log transformation, data were assessed and found to be normally distributed. For internal validity, Cronbach's alpha (α) was tested for multiple items relating to similar dietary items for

raw data only. The *a priori* hypothesis was that consumption of dietary components such as fruits, vegetables, whole grains, low-fat dairy, and other foods promoted in the workshops would increase at T1, and greater increases would be shown in the intervention condition compared to the control group. Pre- and post-assessment comparisons were assessed and significance was determined by student's t-tests for within group comparisons. All statistical analysis was done in SAS 9.4 (The SAS Institute, Cary, NC, USA).

Results

Participants

Baseline demographic data are presented in **Table 5.2**. Data were collected from 53 families at T0, and from 36 families at T1. All participating parents were female, self-report Mexican-American or Puerto Rican, and had at least one child between the ages 6-18. The average age of mothers in this study was 35.2 ± 6.8 years, and the average age of children was 8.9 ± 2.8 years. Twenty-one (58%) of children were female. The majority of mothers (92%) were born in either Mexico or Puerto Rico, and were living in the US for an average of 12.7 ± 5.4 years. The retention rate at T1 was 68%. Only participants with complete data are included in this analysis.

Changes in Parent Diet

At baseline, mean HEI-A score for all mothers was 44.09 ± 15.02 . Scores at baseline between individuals randomized to the control, 41.71 ± 15.82 , or intervention, 46.75 ± 14.02 , groups were not significantly different ($P=0.58$). At T1, total HEI-A significantly increased ($P=0.004$) to 66.06 ± 13.52 for individuals in the intervention condition. In the control group, total HEI-A increases were marginally significant ($P=0.046$) at 52.76 ± 15.69 . Adherence scores

in individual categories also increased in the intervention group. Lean meat consumption, consumption of low-fat dairy, and fruit and vegetable consumption adherence scores all increased significantly at T1. SFA consumption and sugar consumption adherence scores also increased, indicating that consumption of these two food groups went down. Changes in HEI-A scores are presented in **Table 5.3**.

The MEDFICTS questionnaire was completed by 23 individuals at both time points. In the intervention group, mean scores significantly decreased from 62.42 ± 24.88 to 44.75 ± 13.25 ($P=0.029$). In the control group, the mean did not change significantly between baseline, 51.27 ± 19.49 , and T1, 50.64 ± 16.67 .

Changes in Child Diet

Parent reported child diet is presented in **Table 5.4**. Almost all children (97.2%), regardless of treatment group, were consuming milk at least once a day. At baseline, the majority of children were consuming milk (97.2%), fruit (80.5%), and vegetables (55.6%) at least once a day. A high proportion of children were also consuming SSB (69.7%), fried foods (69.4%), or salty snacks such as potato or corn chips (80.0%) at least once a week.

Compared to children in the control group, children in the intervention group significantly decreased frequency of SSB consumption from 6.67 (95% confidence interval [CI]: 2.5 – 10.8) times per week to 2.65 (95% CI: 1.1 – 4.2, $P=0.031$). Frequency of fruit juice consumption significantly decreased in the intervention group, from 7.38 (95% CI: 4.0 – 10.7) times per week to 4.25 (95% CI: 1.4-7.1, $P=0.031$). Fast food consumption remained relatively unchanged in the intervention group, but increased in the percentage of children consuming in

the control group from 55.6% of children consuming fast food at least once in the past week at baseline to 63.2% at T1 ($P=0.849$).

Changes in Child Anthropometrics

At T1, the proportion of children with BMI percentiles in the range of overweight or obesity did not change from baseline in the intervention group. Children randomized to the intervention group who were classified as overweight did not move up into the obesity category. These changes are presented in **Table 5.5**.

Internal Validity

Tests of Cronbach's α for related questions between RYP/REAP and MEDFICTS revealed high validity in questions from both measures. There were several dietary components asked in both surveys (i.e.: dairy, sugary snacks, and lean proteins). All standardized α values were greater than 0.70, indicating acceptable reliability (13).

Discussion

The aim of the present study was to examine changes in parent and child diet after exposure to a nutrition education program. The hypothesis was that participants in the intervention group, compared to those in the control group, would have increases in diet quality. For adults, this was confirmed through significant increases in both HEI-A score and in the individual components of lean meat and low-fat dairy consumption, and decreasing SFA intake. Indeed, a significant reduction in the mean MEDFICTS score, indicating decrease in total fat intake, especially in total calories from SFA also confirmed the hypothesis (11). In children, SSB intake was decreased significantly among children in the intervention group.

In epidemiologic studies, Hispanics report high intakes of both SSB and SFA compared to other ethnic groups in the US (4). However, our study demonstrates that it is possible to modify these dietary habits through nutrition education programs. The AC2 curriculum combined lectures with discussions, hands-on food demonstrations, and interactive activities to build content knowledge and dietary self-efficacy, in accordance with social cognitive theory (14). The curriculum also employed cultural tailoring through use of Spanish-language materials, consideration of cultural values, and use of traditional foods as examples. A similar intervention targeted at modifying diet in Hispanic females was also successful in increasing overall diet quality, assessed by a validated scale to assess adherence to a heart-healthy diet in Hispanics (15). Like AC2, this intervention was culturally-tailored. Another intervention for Mexican women with overweight and obesity has success in increasing water intake and decreasing SSB, when beverage choice was the only nutrition concept taught in the intervention (16). This study also reported significant improvements in metabolic outcomes related to decreases in SSB consumption, as women with obesity who replaced water for SSB had decreased circulating levels of serum triglycerides, one of the defining criteria for Metabolic Syndrome, and a risk factor for development of cardiovascular disease (17). Modification of even one aspect of the diet can have important consequences for health, especially in the case of prevention of obesity and related diseases (18).

The results of change in child diet mimic those of the parents, by decreasing intake of SSB and among children in the intervention at T1. Across both treatments, frequency of consumption of fruits and vegetables remained high, consistent with previous research (4, 5). Among children enrolled in the intervention, consumption of 100% fruit juice significantly decreased in the intervention group, and increased in the control. This was initially unexpected,

however, consumption of whole fruits over fruit juice was emphasized during nutrition classes, for nutritional benefits such as fiber that are not present in juice. The AC2 intervention was also preventative against weight gain in children between T0 and T1, shown by no changes in BMI percentile of the children enrolled in the intervention.

Our study has the following strengths. First, our intervention was both family-focused and culturally-tailored, reflecting the values and traditions of the target populations. In Hispanic culture, the family unit is valued over the individual (19). Capitalizing on family support, combined with traditional recipes and food demonstrations allowed for effective reception of a non-generalized approach to nutrition education, resulting in improvements in parent and child diet. Another strength is the examination of parent diet. Many family-focused programs for childhood obesity prevention, such as AC2, have not reported measures of parent diet, despite the parental role as gatekeepers and influencers over child diet (20). Both Hull et al. and Fable et al. were successful in either preventing or treating prevalence of child overweight and obesity, but only collected measures on child diet, despite also involving parents in nutrition classes (21, 22). There is evidence that Hispanic parents serve as role models for child diet, especially in consumption of fruits and vegetables (23). Finally, the dietary measures used in this study had high internal reliability, with high Cronbach's α values, allowing the researchers to conclude that low-literacy participants were able to understand and complete the survey.

The present study does have several limitations. HEI-A scores were calculated from the results of a quantitative measure and not a 24-h diet recall, so many not fully encompass all the foods consumed by participants. The questions asked on the measures chosen in this survey may not encompass all food groups eaten by the participants in the past week or month. Many aspects of the traditional Hispanic diet, such as corn tortillas and beans, are not asked in these measures.

The majority of the mother's in this sample were not born in the US, and so it is possible that they still consume diets similar to that in their home country (24). Child dietary intake was collected via parent-report, which may be subject to error if children are consuming foods outside the home or if parents work outside the home. However, before the age of nine, children may not have the developmental capacity to provide accurate dietary recall information (25). Therefore, the measure used in this study may be an effective compromise of parents knowing the overall patterns of their child's intake.

In conclusion, the AC2 intervention was able to modify unfavorable dietary behaviors and prevent weight gain in both children and adults, compared to the control group. Use of the HEI-A to evaluate diet quality allowed for assessment of adherence to the *2015 Dietary Guidelines for Americans* and the AC2 nutrition lessons, which were created with the DGA as the primary source for content. The AC2 intervention integrates cultural-tailoring, emphasis on the family, and community involvement, and has been shown to be an efficacious strategy for improving health in Hispanic families.

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Tables

Table 5.1. Comparisons between the 2010-HEI and the HEI-A (adherence to the 2015 Dietary Guidelines).

2010 Healthy Eating Index (HEI 2010)		Adherence Health Eating Index (HEI-A)	
<i>Component</i>	<i>Standard for Maximum Score</i>	<i>Component</i>	<i>Standard for Maximum Score</i>
Total Fruit	≥ 0.8 cup/1000 kcal	Fruits	2 cups/ day
Whole Fruit	≥ 0.4 cup/1000 kcal		
Total Vegetables	≥ 1.1 cup/1000 kcal	Vegetables (from more than one subgroup)	3 cups/ day from at least 2 subgroups
Greens and Beans	≥ 0.2 cup/1000 kcal		
Whole Grains	≥ 1.5 ounce/1000 kcal	Whole Grains	4 ounces/day
Refined Grains	≤ 1.8 ounce/1000 kcal		
Dairy	≥ 1.5 cup/1000 kcal	Dairy	3 cups/day
		Low-fat Dairy	Regular consumption
Total Protein Foods	≥ 2.5 ounce/1000 kcal	Protein Foods	6 ounces/day
Seafood and Plant Proteins	≥ 0.8 ounce/1000 kcal	Variety of Lean Proteins	Consumption from two or more protein groups
Fatty Acids	$[(\text{PUFAs} + \text{MUFAs}) / \text{SFAs}] > 2.5$	Limiting Saturated Fat Intake	<10% of calories
		Non-tropical oils	Increased consumption compared to SFA
Sodium	≤ 1.1 gram/1000 kcal	Sodium	<2300 mg/day
		Sugar	Limited consumption
Empty Calories	$\leq 19\%$ of energy		

Table 5.2. Baseline characteristics of participants.¹

	Intervention (n=17)	Control (n=19)	P-value
Parent age (years)	36.82 ± 7.06	33.68 ± 6.34	0.085
Child age (years)	8.76 ± 3.23	9.00 ± 2.49	0.404
Household income	\$22,800 ± 11,200	\$21,500 ± 10,900	0.368
Years in US	12.2 ± 5.43	13.36 ± 5.48	0.298
Adults			
BMI (kg/m ²)	30.79 ± 4.31	34.08 ± 8.67	0.049
% with BMI 25-30 kg/m ²	50.00%	22.22%	0.047
% with BMI ≥ 30 kg/m ²	50.00%	72.22%	0.194
Children			
% with age-sex specific BMI percentile 85 th -95 th	14.29%	17.65%	0.905
% with age-sex specific BMI percentile ≥95 th	28.57%	52.94%	0.074

¹Data are presented as mean ± standard deviation unless otherwise stated. Differences between groups at baseline were determined by student's t tests. BMI = body mass index

Table 5.3. Changes in mothers' diet quality (HEI-A Scores) before and after AC2 intervention.²

HEI-A Category	T0 Baseline (n=36)	T1 Intervention (n=17)	T1 Control (n=19)
Total HEI-A Score	44.66 ± 13.50	66.06 ± 13.52 ^b	52.76 ± 15.69
Lean meat consumption	5.20 ± 2.07	6.85 ± 1.26 ^a	5.26 ± 1.21
Consumption of variety of lean proteins	3.31 ± 2.69	4.61 ± 1.72	4.30 ± 1.43
Consumption of low-fat dairy	4.26 ± 3.11	7.35 ± 2.42 ^a	5.39 ± 3.03 ^a
Adequate dairy consumption	4.86 ± 3.73	5.88 ± 3.64	5.26 ± 3.53
Consumption of mostly whole grains	5.14 ± 4.11	7.35 ± 3.59	6.32 ± 3.67
Consumption of fruits & vegetables	3.07 ± 3.54	6.47 ± 2.94 ^a	2.63 ± 3.06
Limited consumption of saturated fat	5.23 ± 1.81	7.84 ± 1.25 ^b	6.14 ± 1.95 ^a
Consumption of non-tropical oils	3.71 ± 3.13	5.00 ± 1.86	3.51 ± 1.35
Limited consumption of sodium	5.00 ± 3.78	6.18 ± 4.16	6.84 ± 4.15
Limited consumption of sugar	6.11 ± 3.01	8.53 ± 2.35 ^a	7.11 ± 3.46

²HEI-A is scored from 0-100, with increased scores reflecting greater adherence to the 2015 *Dietary Guidelines for Americans* and greater diet quality. The ten individual components are scored from 0-10. Significance between two time points was tested for intervention effects, with values marked ^a representing a P-value <0.05 and ^b representing a P-value <0.01.

Table 5.4. Child diet (expressed as weekly consumption) for intervention and control conditions.³

Intervention (n=17)			
Variable	T0	T1	P-value
SSB	6.67 (2.5-10.8)	2.65 (1.1-4.2)	0.031^a
Fruit Juice	7.38 (4.0-10.7)	4.25 (1.4-7.1)	0.031^a
Fruit	11.76 (8.4-15.2)	11.81 (6.3-17.3)	0.952
Fried Foods	3.64 (1.6-5.7)	2.13 (0.5-3.73)	0.076
Vegetables	8.65 (3.7-13.6)	9.59 (5.3-13.8)	0.713
Fast Food	2.24 (0.9-3.6)	2.12 (0.7-3.5)	0.848
Sweets	4.69 (1.1-8.3)	4.65 (1.8-7.5)	0.943
Salty Snacks	3.56 (2.1-5.0)	5.00 (1.4-8.6)	0.478
Control (n=19)			
Variable	T0	T1	P-value
SSB	5.33 (1.9-8.7)	5.05 (2.0-8.1)	0.990
Fruit Juice	4.71 (2.4-7.0)	4.84 (2.2-7.5)	0.652
Fruit	9.05 (6.1-12.0)	9.58 (7.1-12.0)	0.792
Fried Foods	3.84 (2.0-5.7)	2.56 (1.0-4.1)	0.270
Vegetables	5.58 (3.4-7.8)	5.78 (3.2-8.3)	0.856
Fast Food	1.84 (0.7-3.0)	2.68 (0.9-4.4)	0.358
Sweets	4.44 (2.7-6.2)	4.95 (2.4-7.5)	0.661
Salty Snacks	3.53 (1.8-5.3)	4.79 (1.9-8.0)	0.476

³Data are reported as times consumed in the past 7 days, mean (95% confidence interval). SSB = sugar-sweetened beverages. Differences between baseline (T0) and post-intervention (T1) were determined by paired student's t tests. Items marked ^a were statistically significant at a P-value < 0.05.

Table 5.5. Changes in child and parent body mass index.⁴

		Intervention			Control		
		Mean	SD	P-value	Mean	SD	P-value
BMI (adults)	T0	30.67	4.21		34.65	8.77	
	T1	30.51	4.57	0.094	33.81	8.47	0.258
BMI Percentile (children)	T0	73.50	21.67		79.05	28.9	
	T1	75.86	19.86	0.233	81.59	24.19	0.946
		OW	OB	OW + OB	OW	OB	OW + OB
Weight	T0	50.00%	50.00%	100.0%	22.22%	72.22%	94.44%
Category	T1	50.00%	50.00%	100.0%	27.78%	61.11%	88.89%
(adults)	Change	0	0	0	5.56%	-11.11%	-5.55%
		OW	OB	OW + OB	OW	OB	OW + OB
Weight	T0	14.29%	28.57%	42.86%	17.65%	52.94%	70.59%
Category	T1	21.43%	20.00%	41.43%	29.41%	41.18%	70.59%
(children)	Change	7.14%	-8.57%	-1.43%	11.76%	-11.76%	0

⁴Data are presented as mean and SD (standard deviation), or percentage of individuals affected by OW (overweight) or OB (obesity). There were no significant changes in body mass index (BMI) or age-and-sex specific BMI percentile in adults or children between baseline (T0) and post-intervention (T1). There was no weight gain in children in either condition.

Chapter 6: Assessment of Cardiometabolic Health of Hispanic Families Enrolled in a Nutrition Education Program through Minimally-Invasive Screening

Abstract

Background: Hispanics experience disproportionate rates of obesity and related comorbidities, such as cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM). Due to the high number of Hispanics who are uninsured, these rates may be higher than reported, and individuals may not know their risk of disease.

Objective: To assess the prevalence of obesity and related cardiometabolic disease in Hispanic families enrolled in an obesity prevention intervention.

Methods: Biomarkers for CVD and T2DM were obtained through minimally-invasive procedures. Participants were provided with a copy of their results, and encouraged to share with their primary physician. Prevalence of traditional and non-traditional risk factors was compared to national levels in Hispanics from epidemiological studies.

Results: Prevalence of overweight and obesity was greater than the national levels for both children and adults. There was high prevalence of prediabetes in both adult men (66.7%) and women (45.6%). Children in this sample had high blood pressure values when evaluated with age, sex, and height specific growth charts. Almost all participants, adults and children, were also found to have percent body fat values greater than recommended levels.

Conclusion: This sample of Hispanic families was at increased risk for obesity and comorbid diseases, including prediabetes and hypertension. More minimally-invasive screenings are needed in community settings to inform individuals who may be at risk for non-communicable chronic diseases such as CVD and T2DM.

Background

Hispanics in the United States (US) are at increased risk for the development of obesity, partially due to lifestyle factors such as poor dietary choices and low physical activity (PA) levels. This group is also at risk for comorbidities such as type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD). CVD is the number one cause of death in the United States, and the second leading cause of death in Hispanics, yet there is limited research regarding the prevalence of CVD risk factors in this at-risk group (1, 2). The cardiometabolic health of Hispanics, the largest-growing ethnic group in the US, is essential to the health of the country, and if at-risk individuals can be identified earlier, preventative interventions can be implemented before serious complications arise (3).

In 2014, the American Heart Association (AHA) released a scientific statement regarding CVD risk faced by Hispanics in the US, citing a variety of bio-behavioral risk factors unique to the this population (4). These included acculturation, decreased access to healthcare, language barriers, and food insecurity, among others. This expert panel also examined the prevalence, when available, of risk factors for CVD in this population, but came to the conclusion that there are not enough health screens being done in Hispanics to accurately assess the prevalence of risk factors such as high cholesterol, high blood pressure, among others. If more individuals can be screened, it will serve to benefit not only healthcare providers through increased awareness of disease prevalence, but also information for patients regarding the potential need for lifestyle changes or medical interventions if they are indeed at risk.

Theoretical and Conceptual Framework

The Health Belief Model (HBM) is the process of individual's decision to make changes in order to manage disease risk (5). Factors affecting choice include individual perceptions and modifying factors, which interact to produce the final likelihood of action. The HBM is widely accepted as an accurate predictor of health-related behaviors, and can predict the success an individual may have in following health recommendations. Hispanic cultural values may serve as modifying factors in the HBM, and affect the likelihood of taking preventative action against cardiometabolic disease.

One such value is *fatalismo*, or fatalism, which refers to an acceptance of fate as predetermined, and cannot be changed regardless of effort. This belief has been cited in health promotion literature as a potential barrier to adopting healthy changes in Hispanic adults (6). *Fatalismo* may reduce an individual's self-efficacy, and thus confidence in his or her ability to successfully implement beneficial lifestyle changes. Compared to other ethnicities, Hispanics are more likely to approach a diagnosis of CVD with a fatalistic approach and believe that nothing can be done to prevent or ameliorate their condition (7). These beliefs can also serve as modifying factors in the HBM, as barriers to taking preventative action are outweighed by the benefits, if fate is perceived as unchangeable. In cardiometabolic disease prevention, this could mean that an individual will not make preventative lifestyle changes, as these actions have little to no perceived benefit. The role of *fatalismo* in the HBM is represented in **Figure 6.1**.

In order to make health screenings and individual risk of preventable diseases more accessible, point-of-care (POC) testing has become increasingly common in clinical settings. POC testing is a minimally-invasive way to obtain values for CVD and T2DM biomarkers (cholesterol, glucose, blood pressure) that are immediately available for both the patient and provider (8). This allows for the provider to assess the patient's health risk on-site and have a

discussion about the test results. These tests can be a viable option for individuals who lack health insurance or regular appointments with a physician. POC testing can also be used to increase an individual's awareness of his or her personal risk of disease, potentially increasing likelihood of taking preventative action towards health behaviors. Hispanic individuals are also less likely to have health insurance, with 26.5% of individuals under age 65 not having medical insurance, compared to an overall rate of only 13.4% in the US (9). Hispanics, compared to other ethnic groups in the US, are also less likely to recognize risk factors for CVD, or understand it as the leading cause of death (10, 11). If a greater number of Hispanic adults can be screened for risk factors, it will serve to inform the patients of the potential need for lifestyle changes, and seek formal medical attention.

The purpose of this study was to assess the prevalence of obesity and related cardiometabolic disease in a cohort of Hispanic families enrolled in an obesity prevention intervention.

Methods

Participants

Participants were enrolled in an obesity prevention behavioral intervention for Hispanic families, Abriendo Caminos (AC2). AC2 is a multi-state, randomized control trial in which participants enrolled in the intervention condition attend six weekly workshops with lectures and activities to learn about nutrition, PA, and positive family function. Participants were parents and one child between the ages of 6-18 years who were of Mexican-American or Puerto Rican descent.

Data Collection

Data were collected at community centers or in the homes of participants. All members of the research team were either native or fluent Spanish speakers. Informed consent was obtained for all participants, and procedures were explained in either English or Spanish. Consent forms were also available in both English and Spanish. The Institutional Review Board of the University of Illinois at Urbana-Champaign reviewed and approved all study procedures.

Measures

Height and weight were measured by Seca stadiometers and scales, respectively (Seca North America, CA, USA). Each measurement was taken twice, and the average of the two measurements was recorded. Waist circumference was measured at the midpoint of the floating rib and the iliac crest during the midpoint of expiration with the use of inelastic tape measures (Gulick II, Country Technology, Inc., WI, USA). Each measurement was taken twice by trained personnel, and the average of the two measurements was recorded, in order to compare internal validity. Anthropometric measurements were taken according to guidelines set by the World Health Organization (WHO). Body Mass Index (BMI) was calculated by kg/m^2 , and overweight and obesity were diagnosed by the Centers for Disease Control and Prevention (CDC) BMI charts for adults, and by BMI percentile in children was calculated using age-and-sex specific CDC growth charts.

Body composition was measured by bioelectrical impedance analysis (BIA), the InBody230, (InBodyUSA, CA, USA). Pregnant females and individuals with implantable devices (such as a pacemaker) were not eligible for BIA. The research staff asked these two questions before the participant stepped on the machine. BIA has been shown to correlate highly with DXA as accurate measurements of body composition and segmental fat distribution (12, 13). The InBody 230 specifically has been validated for accuracy in both children and adults (14,

15). Blood pressure was measured in the right arm of participants after resting in a seated position for at least 5 minutes with the Omron IntelliSense Digital Blood Pressure Monitor (Omron Healthcare, Hoffman Estates, IL, USA), a device commonly used in clinical and research settings (16). Three readings were taken 60 seconds apart, and the average value was recorded. Total cholesterol (TC), high-density lipoprotein cholesterol (HDL), triglycerides (TG), and glucose were measured from 80 microliters (μL) of capillary blood taken from a finger stick procedure. After blood had been obtained, the CardioChek PA Analyzer (PTS Diagnostics, Indianapolis, IN, USA) was used to process the samples. This device has been validated for field use, allows for immediate results that correlate highly with those obtaining in laboratory settings (17). The use of a finger stick procedure over phlebotomy is less expensive, less of a risk to the participant, and allows for immediate results. HbA1C was measured with the finger stick procedure as the above measures with A1CNow+ Kits (PTS Diagnostics, Indianapolis, IN, USA). These kits have been validated to correlate with laboratory obtained values of HbA1C at a Pearson's coefficient of 0.93 (18). This test can be performed in five minutes, and results are available immediately.

Participants were given a copy of their results, and the meaning of each biomarker was explained. The researcher would also explain comparative standards, and state if the participant's value was outside of the normal range. Participants were encouraged to share these results with their primary physician. No diagnoses were made or given to the participants.

Analysis

To determine prevalence of cardiometabolic disease, diagnostic values for traditional and non-traditional markers of CVD, T2DM, and Metabolic Syndrome (MetS) were obtained from the WHO, AHA, or the American Diabetes Association (ADA) (19-23). These are presented in

Table 6.1. If participants were not fasted for 8 or more hours, the number of hours fasted was recorded, and the values were adjusted. In the case of glucose, values obtained from participants who were fasted less than 2 hours were not included in the final analysis. For children, growth charts were used to determine diagnostic levels. Testing for statistical significance was not performed, as the objective of this study was to present descriptive information only.

Results

Participants

Data were collected from 40 adults (33 females, 7 males) and 27 children (18 females, 9 males). Demographic data for participants are presented in **Table 6.2**. All participants were of self-report Mexican or Puerto Rican descent, and adults were either first (91%) or second (9%) generation immigrants. The average age for adult females was 33.6 ± 6.11 years. The average age of adult males was 30.4 ± 9.83 years.

Obesity

Prevalence of overweight and obesity in adults and children are presented in **Table 6.3**. Prevalence of overweight was 71.4% among adult males and 36.4% among adult females. Obesity prevalence in adult males and females were 28.6% and 51.5%, respectively. In children, prevalence of overweight was 11.1% in boys and 16.7% in girls, and obesity prevalence was 77.7% in boys and 50.0% in girls.

High Blood Pressure

Average values for systolic (SBP) and diastolic blood pressure (DBP) are presented in **Table 6.2**. No adult males were above diagnostic values for blood pressure. Among adult

females, 12.9% were above a diagnostic value of 85 mmHg for DBP. Blood pressure levels in children were evaluated using the sex-age-and-height specific charts published by the National High Blood Pressure Education Program (24). Values were considered high if the child's SBP and DBP were $\geq 90^{\text{th}}$ percentile. Forty percent of all children, 50% of boys and 35.3% of girls were at or above the 90th percentile for their specific age, sex, and height.

High Cholesterol

Average values for TC, HDL, LDL, and TG are presented in **Table 6.2**. The prevalence of hypercholesterolemia, diagnosed by TC ≥ 200 in adults or ≥ 170 in children, was 16.7% and 8.3%, respectively. Among adults, 16.7% of males and 15.4% of females had LDL values of greater than 100 mg/dL. One-third (33.3%) of males and 70% of females had low HDL values. One-third of men (33.3%) and 37.9% of women had TG levels over 150 mg/dL.

High Glucose and HbA1C

The average fasting or adjusted-for-hours-fasted glucose in this sample for adults was 143.3 ± 101.1 mg/dL in males, and 92.1 ± 16.6 mg/dL in females. In children, the average blood glucose was 95.4 ± 21.6 mg/dL. The average hemoglycosylated A1C (HbA1C) was $7.1 \pm 2.5\%$ in males, and $5.6 \pm 0.33\%$ in females. The prevalence of prediabetes (glucose ≥ 100 mg/dL or HbA1C $\geq 5.7\%$) in males was 66.7% and 45.2% in females. Only 16.7% of males and 3.3% had values at or above diagnostic values for diabetes, defined by glucose ≥ 126 mg/dL or HbA1C $\geq 6.5\%$. Eight children (34.8%) had values above 100 mg/dL, and two had values indicative of diabetes (8.7%). These are also presented in **Tables 6.2** and **6.3**.

Body Composition

The results from bioelectrical impedance analysis are presented in **Table 6.2**. The average percent body fat (PBF) was $27.5 \pm 7.3\%$ for males and $43.0 \pm 6.6\%$ for females. The majority of males (71.4%) had PBF in the overweight or obesity range ($\geq 24\%$) (25). In this sample, 75.9% of females had a PBF exceeding 37%, which falls into the range of obesity for females.

In children, risk for high PBF was determined through examination of age-and-sex specific growth charts published by Larson et al. (26). In this sample, 77.8% of boys and 88.2% of girls were determined to be in the high-risk category. The distribution of PBF percentiles are presented in **Figure 6.2**.

Discussion

The purpose of this study was to describe the prevalence of obesity and cardiometabolic risk through a minimally-invasive health screening in a population of Hispanic families enrolled in an obesity prevention program. Individuals in this sample were found to have high prevalence of obesity in both adults and children through both BMI and PBF. Adults in this sample were not at risk for high blood pressure, but did have high rates of pre-diabetes, shown through glucose and HbA1c. When compared to age and sex specific growth charts, many children in this sample had high blood pressure and pre-diabetes.

In the US, the prevalence of obesity is 35.2% for men and 40.5% for women (21). In Hispanics, these rates increase to 38.8% and 46.6% for men and women, respectively. The prevalence of obesity in the US for children 2-19 years of age is 16.9% in males, and 17.1% in females (27). When calculated by ethnicity, the prevalence of obesity in Hispanic children is

22.4% for boys, and 21.4% for girls. In our study, obesity prevalence for all age groups and sexes exceeded the national levels for Hispanics.

Prevalence of traditional and non-traditional CVD risk factors was also examined in this study, and compared to national levels. Among Hispanic adults in the NHANES study, the prevalence of TC levels ≥ 200 mg/dL for males and females was 48.1% and 44.7%, respectively. Thirty percent of Hispanic females and 39% of males have a LDL greater than 130 mg/dL, the highest prevalence of any ethnic group among males in the US (28). In the Study of Latinos (SOL) Hispanic females had a greater prevalence of low HDL (≤ 50 mg/dL) compared to Hispanic men (29). The majority of the females in our study (70%) also had low HDL-C values. In children, LDL and HDL have been shown to be extremely variable both before age 9, and with the onset of puberty around age 12, so TC and non-HDL values are recommended as better predictors of CVD risk (30). However, non-HDL cholesterol was not available in our study.

Hispanics in the US are also at increased risk for hypertension (HTN) and T2DM. In this study, the prevalence of blood pressure values above diagnostic levels ($\geq 130/85$ mmHg) was lower than the national prevalence among Hispanic adults: 30% in males and 29% in females (4). In children, risk for high blood pressure is determined through use age, sex, and height specific standard values (24). These charts are recommended by the NHLBI, but do not take into account ethnic disparities in disease risk, despite evidence that Hispanic children have high blood pressure values, regardless of weight status (31). Hispanic adults are known to be at increased risk for HTN due in part to poor diet and high prevalence of obesity, but there is limited data informing the risk prevalence in children, who are exposed to the same lifestyle factors as their parents. In a cross-sectional analysis of Hispanic families, Gopinath et al. found that children of parents with HTN were more likely to have poor dietary habits, compared to children of non-

hypertensive individuals (32). Though HTN among adults in our sample was not high, other comorbid diseases which were found to be high in our sample, such as pre-diabetes, have been shown to be associated with a strong family history component (33). According to the ADA in 2015, the prevalence of T2DM in Hispanic adults was 12.8%, compared to a prevalence of 9.3% in the general population and 7.6% in non-Hispanic whites (34). However, due to the high number of Hispanics in the US without health insurance or consistent medical care, this number may be even higher when taking into account the number of individuals with undiagnosed diabetes (9). In our study, prevalence of pre-diabetes were high in both children and adults, indicative of increased risk for T2DM.

The comparative standards for PBF in adult males and females were adapted from Gallagher et al. (25), in which the researchers performed regression analysis on data from a large cohort study to determine healthy PBF ranges. However, this did not include any Hispanic participants, and therefore results may not be generalizable. A study by Fernandez et al. investigated the differences in regression models of PBF and BMI in Hispanics compared to other ethnic groups, and found significant differences in PBF at the same BMI levels for Hispanic females compared to other ethnic groups (35). Therefore, it is possible that the cutoffs for PBF may not apply to the women in our sample. For children, the age and sex specific growth charts were created using the NHANES cohort, a diverse and large-scale cohort (36). The majority of the children in this sample were at or above the high-risk values for PBF, placing them at increased risk for adiposity-related metabolic complications (26).

In conclusion, this exploratory study demonstrated the high prevalence of cardiometabolic disease prevalence in a sample of Hispanic families, through use of minimally-

invasive POC techniques, which allowed for immediate results population of Hispanic families is at increased risk for obesity and T2DM. The prevention of obesity and cardiometabolic disease in Hispanic adults and children is key for the future health of the United States, as they are the fastest growing minority group. The increased availability of POC health screens may improve awareness of the individual disease risk, in turn making individuals more likely to seek formal medical attention or modify lifestyle behaviors.

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Tables and Figures

Figure 6.1. Adaptation of the Health Belief Model in Hispanics at risk for cardiometabolic disease. Modified from Becker & Janz (1985).

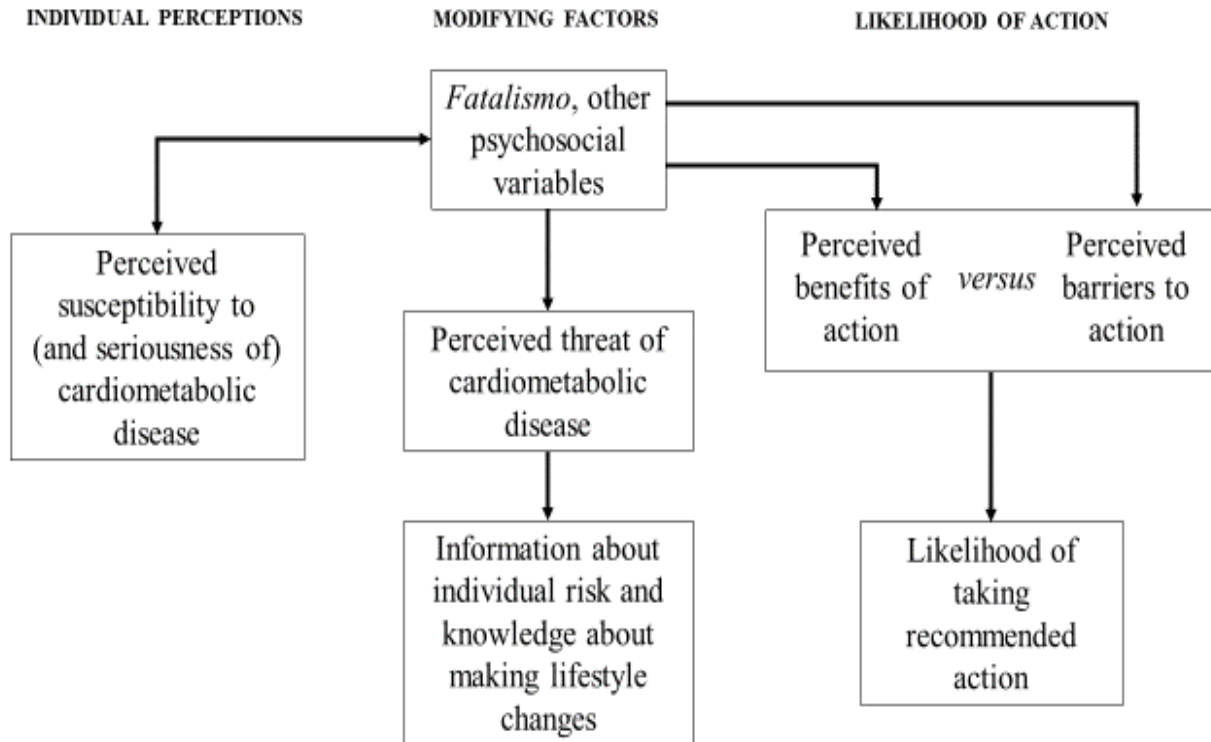


Table 6.1. Diagnostic values for cardiometabolic disease and source of information.¹

Variable	Diagnostic Value
BMI (37)	Adults: $\geq 25 \text{ kg/m}^2$ for overweight; ≥ 30 obesity Children: $\geq 85^{\text{th}}$ percentile for age and sex for overweight; $\geq 95^{\text{th}}$ percentile for age and sex for obesity
WC (20)	Adults: $\geq 94 \text{ cm}$ (men); $\geq 80 \text{ cm}$ (women) Children: $\geq 90^{\text{th}}$ percentile for age and sex
TC (22, 30)	Adults: $\geq 200 \text{ mg/dL}$ Children: $\geq 170 \text{ mg/dL}$
HDL (22)	$< 40 \text{ mg/dL}$ (males); $< 50 \text{ mg/dL}$ (females)
LDL (22)	$\geq 100 \text{ mg/dL}$
TG (22)	$\geq 150 \text{ mg/dL}$
Glucose (34)	$\geq 100 \text{ mg/dL}$ (prediabetes); $\geq 126 \text{ mg/dL}$ (diabetes)
HbA1C (34)	$\geq 5.7\%$ (prediabetes); $\geq 6.5\%$ (diabetes)
Systolic and Diastolic Blood Pressure (22, 24)	Adults: $> 120/80 \text{ mmHg}$ Children: $\geq 90^{\text{th}}$ percentile for sex and height specific charts
PBF (36, 38)	Men: $\geq 24\%$ Women: $\geq 37\%$ Children: $\geq 90^{\text{th}}$ percentile for sex and height specific charts

¹Diagnostic values were obtained from sources such as the World Health Organization, American Heart Association, and American Diabetes Association. BMI – body mass index; WC – waist circumference; TC – total cholesterol; LDL – low-density lipoprotein cholesterol; HDL – high-density lipoprotein cholesterol; TG – triglycerides; HbA1C – hemoglycosylated A1C; PBF – percent body fat.

Table 6.2. Demographic data for all participants.²

Characteristic	Males (n=7)	Females (n=33)	Children (n=27)
Age (years)	30.4 ± 9.8	33.6 ± 6.1	7.8 ± 1.6
BW (kg)	87.1 ± 14.0	73.1 ± 13.9	41.8 ± 18.0
BMI (kg/m²)	29.9 ± 6.2	30.3 ± 4.9	22.0 ± 5.5
BMI percentile (%)	NA	NA	81.1 ± 25.3
WC (cm)	NA	90.5 ± 14.1	64.9 ± 14.9
TC (mg/dL)	147.2 ± 65.2	150.1 ± 27.3	134.9 ± 25.1
HDL (mg/dL)	41.5 ± 9.1	47.0 ± 14.5	40.9 ± 12.1
LDL (mg/dL)	70.4 ± 41.1	71.4 ± 29.3	72.5 ± 30.5
TG (mg/dL)	176.5 ± 161.8	139.6 ± 82.0	102.2 ± 52.5
Glucose (mg/dL)	143.3 ± 101.1	92.1 ± 16.6	95.4 ± 21.6
HbA1C (%)	7.1 ± 2.5	5.6 ± 0.33	NA
SBP (mmHg)	122.8 ± 9.0	108.7 ± 12.9	102.4 ± 10.9
DBP (mmHg)	75.2 ± 9.0	70.8 ± 12.5	64.4 ± 9.6
PBF (%)	27.5 ± 7.3	43.0 ± 6.6	32.3 ± 11.0

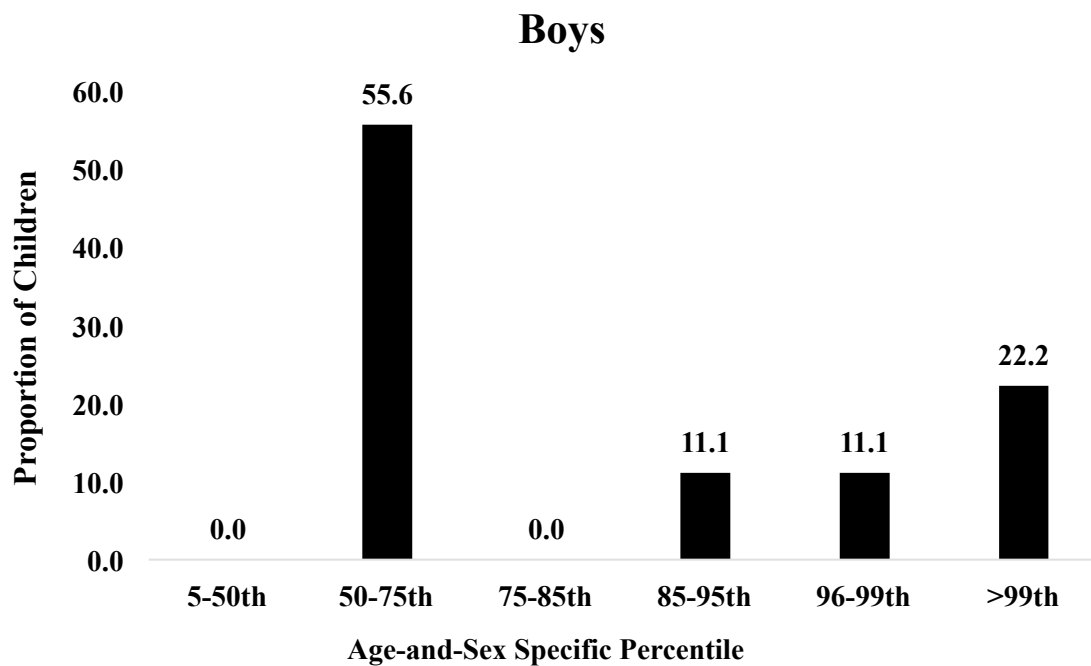
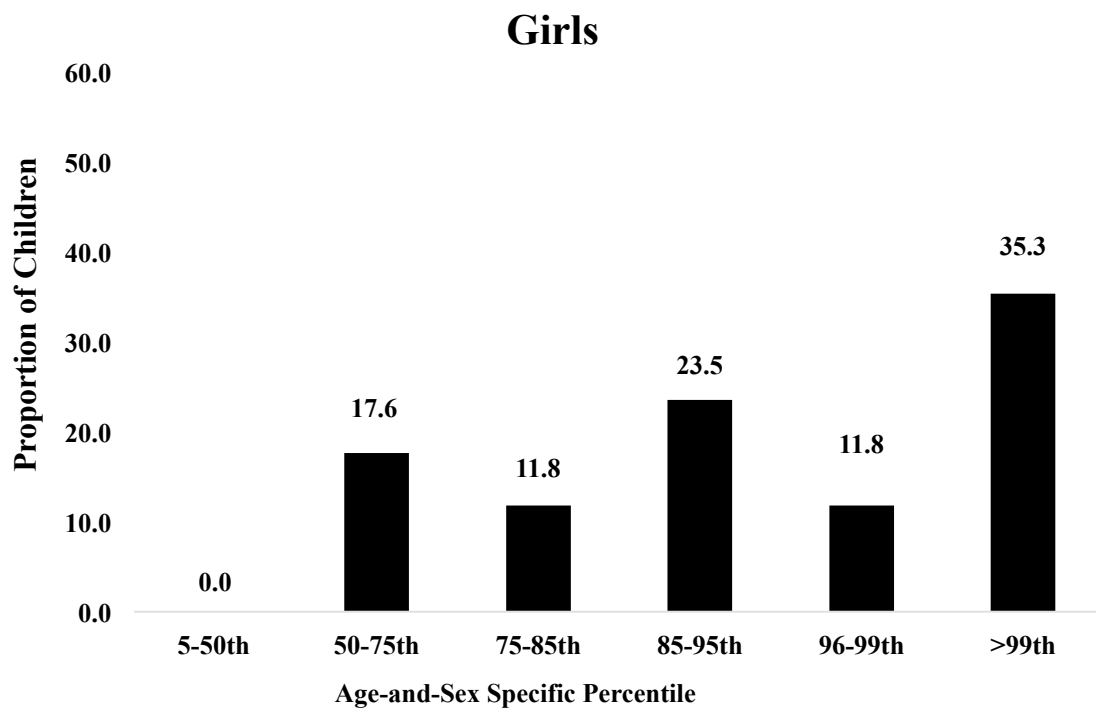
²Data are presented as mean ± standard deviation (SD). Common abbreviations include: BMI – body mass index; TC – total cholesterol; HDL – high-density lipoprotein cholesterol; LDL- low-density lipoprotein cholesterol; TG – triglycerides; HbA1C – hemoglycosylated A1C; BW – body weight; SMM – skeletal muscle mass; LBM – lean body mass; FM – fat mass; PBF – percent body fat; SBP – systolic blood pressure; DBP – diastolic blood pressure; WC – waist circumference.

Table 6.3. Prevalence of obesity and diagnostic values of cardiometabolic biomarkers in the AC2 cohort.³

Risk Factor	Adults		Children	
	Males n=7	Females n=33	Males n=9	Females n=18
Overweight	71.4	36.4	11.1	16.7
Obesity	28.6	51.5	77.7	50.0
High TC	16.7	0	11.1	5.6
High LDL	16.7	15.4	NA	NA
Low HDL	33.3	70	NA	NA
High TG	33.3	37.9	NA	NA
Prediabetic range – high Glucose or HbA1C	66.7	45.2	44.4	0.0
Diabetic range – high Glucose or HbA1C	16.7	3.3	0	11.5
High Blood Pressure	0.0	12.9	50.0	25.3
High PBF	71.4	75.9	77.8	88.2

³Data are presented as percentage of individuals at or above diagnostic criteria. TC – total cholesterol; LDL – low-density lipoprotein cholesterol; HDL – high-density lipoprotein cholesterol; TG – triglycerides; HbA1C – hemoglycosylated A1C; PBF – percent body fat.

Figure 6.2. Distribution of percent body fat (PBF) percentiles for boys and girls.



Chapter 7: Conclusions and Future Directions

The work presented in this thesis was developed through support from the National Institute for Agriculture under the AFRI Childhood Obesity Prevention Challenge Area grant (2015-68001-23248) to the University of Illinois for the *Abriendo Caminos* program (AC2). AC2 is a multi-site, integrated workshop curriculum to prevent childhood obesity in Hispanic families through nutrition education via family-focused, culturally-tailored workshops. The original curriculum, developed in 2006, integrated socio-cultural and socio-ecological theory with elements of the health belief model to encourage behavior change through multiple levels of influence: individual, interpersonal, and community. It resulted in modification of dietary patterns in children (1). AC2 is a multi-model program that includes nutrition education, physical activity, and improving family togetherness. The purpose of this thesis was to adapt the original nutrition curriculum, deliver the AC2 program in a randomized control trial, and evaluate its efficacy through changes in dietary patterns and anthropometric measurements at the Illinois site. Body mass index (BMI) was used as a proxy for changes on body mass. This was done through the following aims.

Aim 1 was to adapt the *Abriendo Caminos* nutrition curriculum to reflect elements of social cognitive theory (SCT), community feedback and cultural tailoring, and recent evidence-based nutrition. These adaptations were completed following thorough literature review of successful interventions in Hispanic populations and examination of policy and scientific statements related to nutrition and management of obesity in adults and children (2, 3). Described in **Chapter 4**, the updated and adapted curriculum is reflective of behavioral theory, community feedback, and advances in nutrition evidence. It included additional food demonstrations and hands-on activities not present in the original curriculum, and additional

content for parents to reflect recommendations of the *2015 Dietary Guidelines for Americans*. A potential limitation is the regional adaptations that will be done in the four partner sites (California, Iowa, Texas, and Puerto Rico). As partner sites gather feedback from the surrounding Hispanic communities regarding common foods and dietary habits, the subsequent modifications to the curriculum could impact program integrity. However, though food demonstrations and examples may differ by site, the evidence and behavior theory that have been integrated into the curriculum will not be affected, and will not affect program fidelity. Participants will learn the same content through lectures and interactive activities, but with foods that are more commonly consumed in that region. Future directions for this research include these site-specific adaptations, and evaluation of the AC2 curriculum at the other partner sites.

Aim 2, as reported in **Chapter 5**, was to evaluate the effectiveness of the adapted AC2 curriculum through changes in dietary patterns and BMI. Specifically, BMI was used in adults, and corresponding age-and-sex specific BMI percentiles were used for children. To date, 36 families (17 intervention/19 control) were enrolled in the AC2 program. Compared to the control group, mothers enrolled in the AC2 intervention had increased overall diet quality, expressed by adherence to the key recommendations of the *2015 Dietary Guidelines for Americans* (3). Mothers also reported significantly lowering consumption of saturated fats. Children significantly decreased consumption of sugar-sweetened beverages (SSB) and fruit juice, assessed by frequency of consumption over the past week. SSB and saturated fat are two areas of the diet that Hispanics typically overconsume, compared to other ethnic groups, as reported in epidemiological studies (4). Both mothers and children enrolled in the intervention did not experience significant increases in BMI or BMI percentile, illustrating the efficacy of the AC2 intervention in slowing the weight gain trajectory in these children. Limitations of this aim

include a limited sample size, and the potential errors associated with the choice of dietary measures used. In regard to sample size, the AC2 workshops will continue in Illinois in 2017, with a target of recruiting an additional 50 families. The partner sites will continue to recruit and deliver workshops to families, allowing for the efficacy of the AC2 program to be evaluated at multiple intervention sites. The dietary measures used were not comprehensive food-frequency questionnaires (FFQ), and there are certain aspects of participants' diets that could have been missed. Though research assistants were available to assist participants completing the survey, administering a more thorough FFQ or 24-hour recall was not feasible. A strength of the measures chosen is their ability to be quickly completed by an individual without assistance from a health care professional, with the purpose of assessing overall diet quality (5, 6). Future directions for measuring dietary intake among participants of AC2 include potential inclusion of comprehensive FFQs to specifically target intake of Hispanic foods commonly consumed in this population, and analysis of other important components of the AC2 curriculum, such as physical activity or family mealtime frequency.

Aim 3, reported in **Chapter 6**, was to conduct an assessment of the cardiovascular and metabolic health of families enrolled in the AC2 program through minimally invasive, point-of-care screenings. It was found that the majority of the participants had overweight or obesity, and they were specifically affected by increased body fat percentage (PBF). Children in this sample also had high blood pressure values, likely secondary to overweight and obesity. A limitation of this aim is that this was an exploratory, cross-sectional analysis of 67 individuals, and data obtained cannot be used to determine longitudinal health status. Another limitation is that many of the diagnostic values used to determine risk for cardiovascular or metabolic disease were from large studies that did not account for race/ethnicity, despite evidence that Hispanics have higher

values, specifically in PBF and blood pressure, than the general US population (7, 8). The purpose of this aim was not to make diagnoses, but to inform participants about risk factors of cardiovascular disease, and encourage them to continue to see their physician regularly for preventative care. The implications of this pilot study will be important in evaluating effects on biological outcomes of the AC2 program, and the health status of this at-risk community.

Future directions also will include additional statistical analysis in order to more accurately determine the causal relationships between exposure to the AC2 intervention and changes in dietary intake. The analyses done for this thesis was preliminary, and will continue as more families are enrolled in the intervention. First, examination of the participants who were lost to attrition will be completed, in order to determine if their inclusion would have altered final results, or if this group is significantly different in regards to dietary habits or other psychosocial variables compared to the families who stayed in the program. Additionally, analysis of variance (ANOVA) will be used to examine the changes in the child dietary intake between the two experimental groups. The paired t-test, which was used in this preliminary report, allowed for comparison within experimental groups. Conducting ANOVA will allow to better characterize the changes between groups to be compared. This will also be done for the anthropometric measurements, and BMI percentile, rather than weight class, will be used as a continuous variable. By using different analytical models, I will also be able to adjust changes in intake for age of the child, acculturation levels, family income, among other variables. Additionally, calculations to determine inter-rater reliability will be completed for all anthropometric measurements taken for both adults and children.

Overall, the results of this research will serve to inform future community intervention programs regarding the importance of cultural tailoring and family inclusion when working with

Hispanics. The AC2 program is unique in that nutrition education is taught as part of the overall message of promoting healthy families through preparing nutritious meals and being physically active together. The ultimate goal is prevention of childhood obesity, with consideration of familial and environmental influences of the child's health related behaviors that can potentially be modified (parental diet, PA environment, family mealtimes). Consideration of these influencers in the context of Hispanic culture is also important in designing tailored programs, as familial roles and parenting styles also shape the child's food environment and eating practices (9). Future implications for research also include continued development of dietary measurement tools that comprehensively capture dietary habits of diverse populations, without being an inconvenience to the participant. Additionally, there are still many measurement errors in self-report dietary intake data due to recall errors or lack of knowledge regarding portion sizes, so continued research into more objective measures of collection energy intake, such as biomarkers of nutrient intake or metabolic abnormalities, especially in low literacy populations (10, 11).

Finally, more work is needed in determining ethnicity-specific cutoffs for biomarkers for obesity and cardiometabolic disease risk. Hispanics are still underrepresented in epidemiological and health studies. The National Nutrition and Health Examination Survey (NHANES), is regarded as one of the largest epidemiological studies to assess the health of the US population. However, the sampling employed by the NHANES data collection team may not be accurately representative of the US Hispanic population. The Hispanic HANES study was conducted in 1982-1984 from Hispanics living in three different areas of the US, but does not reflect the current health of the Hispanic population now. However, it was not until more recently that Hispanics were not considered one group, but a diverse range of peoples from different countries and backgrounds. The Study of Latinos (SOL) has collected information from Hispanics of five

subgroups living in different places across the country, and is considered one of the largest epidemiological studies on Hispanics to date (9). The Multi-Ethnic Study of Atherosclerosis (MESA) has also recruited and collected data on over 1,400 Hispanics in the US (12). Still, more research is needed among diverse groups at increased risk for disease due to lifestyle or genetic factors. Large sample size studies with long follow-up duration are needed in order to assess the health of Hispanics across the lifespan.

Prevention programs for the prevention of obesity in Hispanics, such as *Abriendo Caminos*, can have sustained, beneficial outcomes in behavior change. In order to ensure success in behavior modification, interventions must be tailored to the population they will serve. This tailoring can be done through inclusion of cultural values and traditional dishes, or through examination of theoretical framework that has been implemented in similar settings. Understanding and implementing cultural framework, especially in family-focused programs, will be more successful than generalized approaches in prevention of obesity progression in this highly at-risk population.

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Appendix A. Behavioral Interventions for Hispanic Children

Study	Target Population	Study Size	Setting	Duration (weeks)	Cultural Tailoring	Workshop Style	Outcomes of Interest
Barkin (2012) "Salud Con La Familia"	Parents and children (ages 2-6)	75 dyads	Community recreation center	12	Yes – Spanish language and use of other tailored program	Skill building sessions with parents and children together	Absolute BMI (child)
Davis (2013) "The Healthy Hawks Program"	Parents and children with overweight or obesity (ages 2-18)	210 dyads (58.6% Hispanic)	Community recreation center	12	No	Lectures, goal setting, and skill building with parents and children taught separately. Families engaged in PA together	BMI z-score, PA, child and parent diet
Parra Medina (2015) "Y Living Program"	Parents and children (ages 7 or younger)	180 dyads	Community recreation center	12	Yes – (unspecified)	Lecture, discussion, reflection, and PA. Families taught together.	Child and adult BMI, WC, body composition
Shaibi (2012) "Every Little Step Counts - Diabetes Prevention Program"	Parents and children with overweight or obesity (ages 14-16)	15	Community recreation center	12	Yes – integration of Hispanic cultural values	Goal setting, discussion, making small changes. Families taught together.	Child values for glucose, insulin, PA levels, diet
Horton (2013) "Entre familia: reflejos de salud"	Mothers and children (ages 7-13)	361 dyads	Home	14	Yes - used <i>promotoras</i> and a telenovela	Family relationships, stress eating, communication, healthy eating, FV, social support,	Child diet

Study	Target Population	Study Size	Setting	Duration (weeks)	Cultural Tailoring	Workshop Style	Outcomes of Interest
Hull (2016) and Zoorob (2013) "Familias Saludables Activas"	Parents and children (ages 5-7)	271	Community setting	16 weeks of contact followed by 32 week reinforcement period	Yes – presentations included pictures of Hispanic families	Families were taught together, engaged in PA	Parent and child diet, PA
Falbe (2015) "Active and Healthy Families"	Parents and children with overweight and obesity (ages 5-12)	55	Primary care physician office	10	Yes - use of <i>promotora</i> , cultural recipes, addressed stress associated with immigration	Physician would met with families every week. Families taught together about nutrition. Children engaged in PA separately.	Child BMI, BP, lipids, glucose, insulin, HOMA-IR
Kilanowski (2015) "Midwest Migrant Education Program)	Parents and children with overweight and obesity (ages 5-12)	171	Community Center	7	No	Only children had nutrition and cooking classes, education materials were sent home to parents.	Child weight, BMI, BMI percentile, nutrition knowledge
Bourdreau (2013) "Healthy Living Today!"	Parents and children with overweight and obesity (ages 9-12)	26	Primary care physician office	24. Classes at weeks 1-5 and 12, coaching every 4 weeks after	Yes – classes discussed overcoming barriers specific to Hispanics	Families taught together. Additional coaching sessions about stress and barriers to health.	Child quality of life, nutrition knowledge & dietary intake, child BMI, lipids

Study	Target Population	Study Size	Setting	Duration (weeks)	Cultural Tailoring	Workshop Style	Outcomes of Interest
Alexander (2014)	Children ages 6-8	188	School	24	No	Children had weekly nutrition and cooking classes, 150 minutes of PA per week. Parents of children with overweight or obesity were brought in for counseling.	Child BMI
Cong (2012) "Transformacion Para Salud"	Parents and children (ages 5-9)	296 dyads	School	10	Yes - adapted another bilingual program	Lessons on nutrition and gardening, additional PA classes. Notes sent home to parents, as well as monthly visits from <i>promotoras</i> .	Child sedentary behaviors
Spears-Lanoiz (2015) and Evans (2016) "Texas! Go! Eat! Grow!"	Parents and children (ages 7-9)	1206 (52% Hispanic)	School	20	No	Dependent on treatment, but included either nutrition classes, gardening, or increase physical activity	Child BMI, diet, PA
Johnston (2013)	Children ages 10-14	173	School	24	Yes - used traditional dishes as examples	Intervention: weekly nutrition classes, daily PA.	Child BMI, body composition, lipid panel

Study	Target Population	Study Size	Setting	Duration (weeks)	Cultural Tailoring	Workshop Style	Outcomes of Interest
de la Torre (2013) "Ninos Sanos Familia Sana"	Parents and children (ages 3-8)	217	School, community center, grocery stores	3 years	Yes – language, food examples	Families educated together. Combined lectures, discussion, skill-building activities, and PA classes. Parents also given grocery store vouchers for produce.	Rate of BMI growth, diet, PA
Gatto (2012) "LA Sprouts"	Parents and children (ages 9-11)	104	School, community garden	12	Yes - used culturally relevant foods such as cilantro, <i>nopales</i> , beans, corn, squash	Children given interactive cooking and nutrition lessons, Also had gardening lessons and visits to farmers' markets	Child motivation for healthy eating, fruit and vegetable enjoyment, BMI, percent body fat
Ziebarth (2012)	Parent and children described as "school age"	47	School, community center	8	Yes - "culturally appropriate supplemental handouts"	Families taught together about energy balance, portions, healthy substitutions, less screen time, PA.	Child BMI, nutrition knowledge
Crespo (2012) "Aventuras Para Ninos"	Parents and children (ages 6-8)	808 dyads	School, home, and community	3 years	No	4 conditions: home (<i>promotora</i> use), community, home+community, or control.	Child and parent BMI, PA, child diet

Appendix B: Handy Portion Guide

El Secreto de las Porciones está en tus Manos



Un puño de tú mano = una taza
= 1 onza (como 30 gr.) de cereal seco
= 2 oz. (como 60 gr.) de cereal cocido, arroz o pasta
= 8 oz. de leche o yogurt = 1 pieza de fruta
= 1 papa mediana = 1 taza de ensalada

El dedo pulgar = 1 cucharada
Consumir 1 oz. (como 30 gr.) de queso bajo en
grasa te ayuda a cubrir una de las 3 a 5
Porciones diarias de lácteos que debes tener.
Es igual a 1 taza de leche o yogurt



Lo que te cabe en la mano = 1 oz.
1- 2 porciones de colación
Ejemplos: cacahuates, nueces,
almendras, "Baked chips",
pretzels, frutas secas,
pasas, arándanos



**¡Las "Botanas" entre comidas
también cuentan!**



La Palma de la mano
= 3 oz. (90 - 100 gr.)
= 1 porción de proteínas
Escoge carne ó pollo sin grasa,
pescado ó mariscos.
Los frijoles también son una buena fuente de proteína.

La punta del pulgar
= 1 cucharadita

= 1 porción de grasa
Ejemplos: la mantequilla de cacahuete,
la mantequilla, la mayonesa.
Coma lo mínimo de estos alimentos



Una pelota de Tenis =
1/2 taza de frutas ó vegetales
Incluya una variedad de frutas y
vegetales todos los días.
= 7 – 8 Baby -carrots,
= ½ Taza de Uvas
= ½ Taza de palomitas
(sin sal ni mantequilla)
= 1 Elote mediano

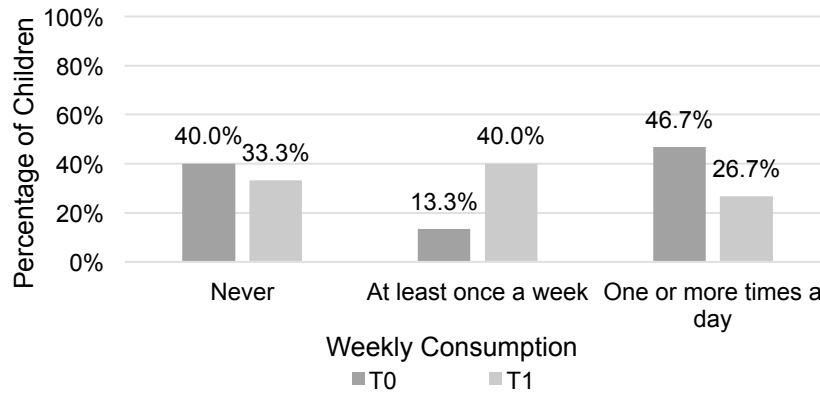
Adapted from Iowa WIC Program – Iowa Department of Public
Health – 2007 Adapted from North Carolina Nutrition Network

Appendix C: Demographic Characteristics of AC2 Cohort

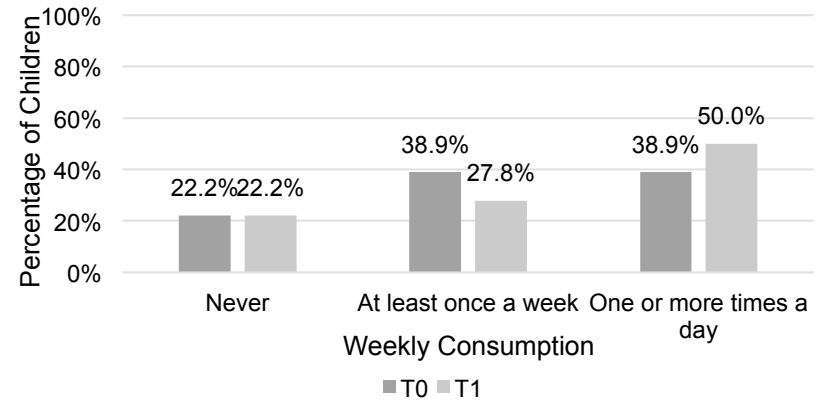
Variable	Mean (\pm SD)	Range
Age (mothers)	35.7 \pm 6.9 years	24 – 47 years
Years in US	12.7 \pm 5.4 years	3-24 years
Number of Children	2.4 \pm 1.0 children	1-5 children
Average Age of Children	9.4 \pm 6.0 years	1 – 23 years
Average Household Income	\$22,200 \pm \$10,900	\$10,000 – \$45,000
Average Age (Target Child)	8.9 \pm 2.8 years	6 – 13 years
Percent Females (Target Children)	58%	NA
Hispanic Origin	92% Mexican-American 8% Puerto Rican	NA
Percent not born in US	92%	NA

Appendix D: Changes in Child Diet

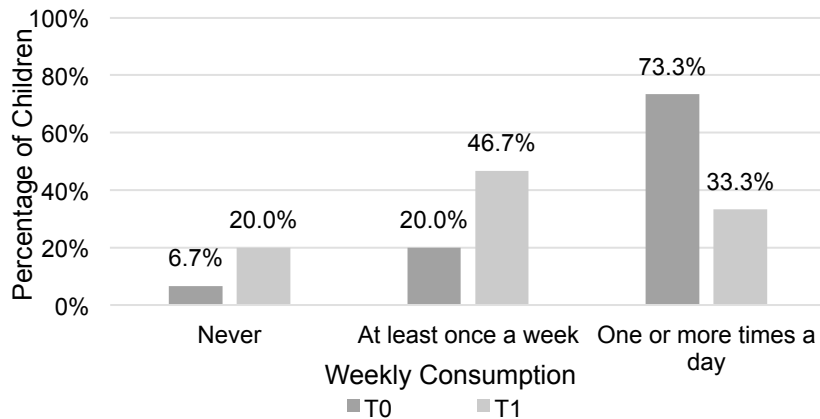
SSB Intake - Intervention



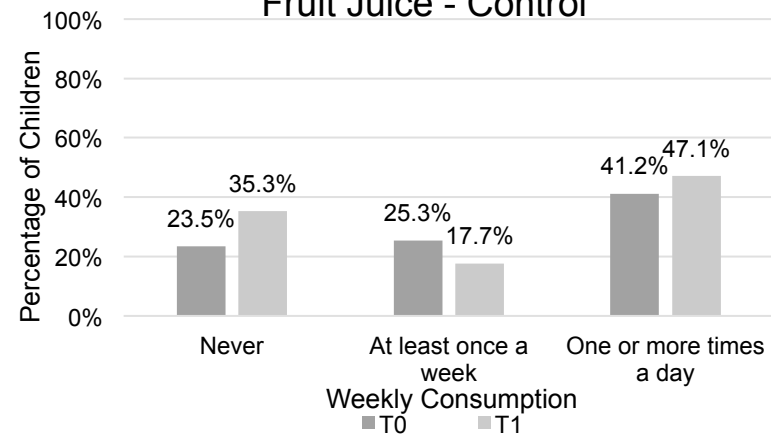
SSB Intake Control



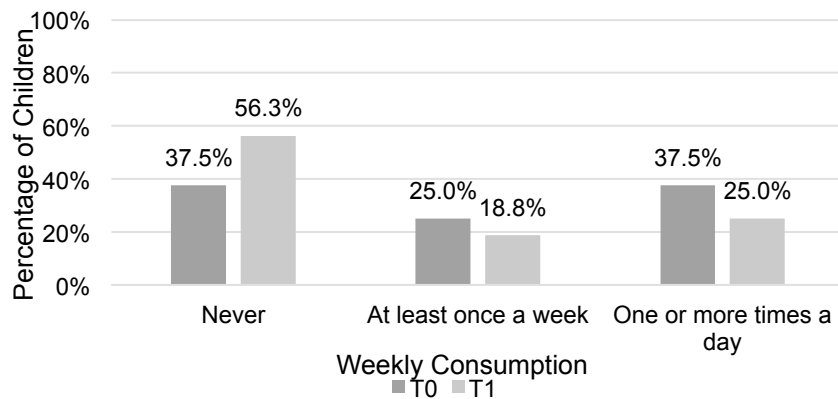
Fruit Juice - Intervention



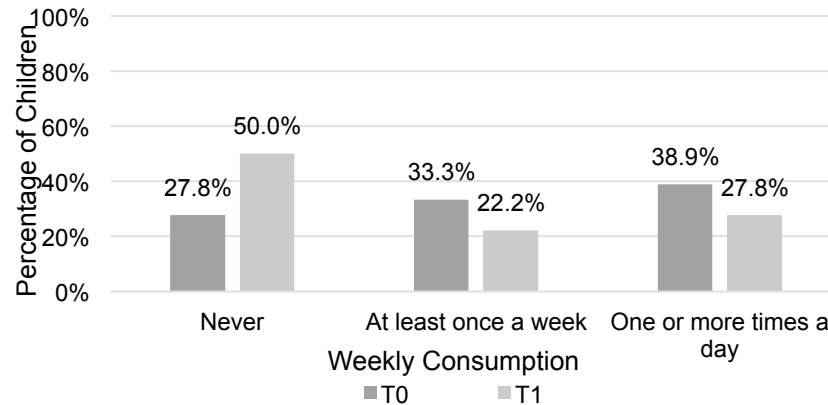
Fruit Juice - Control



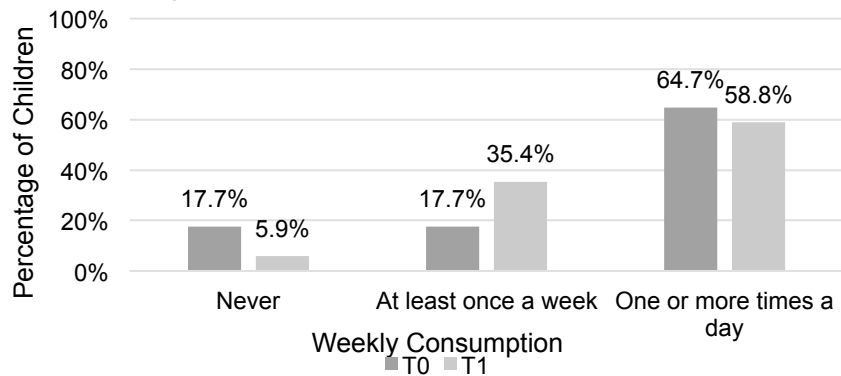
Fried Potatoes - Intervention



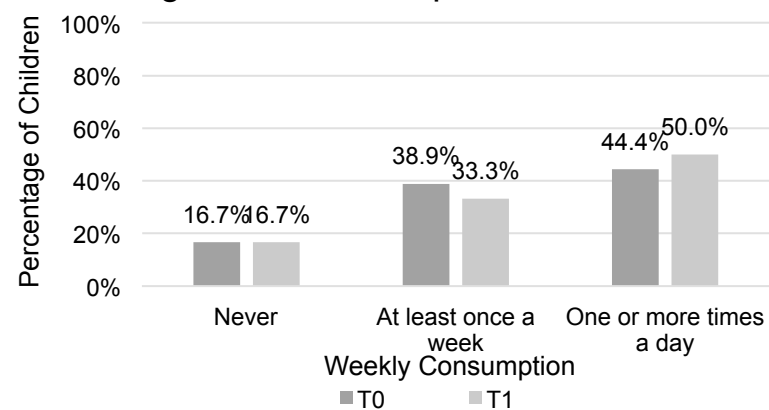
Fried Potatoes - Control



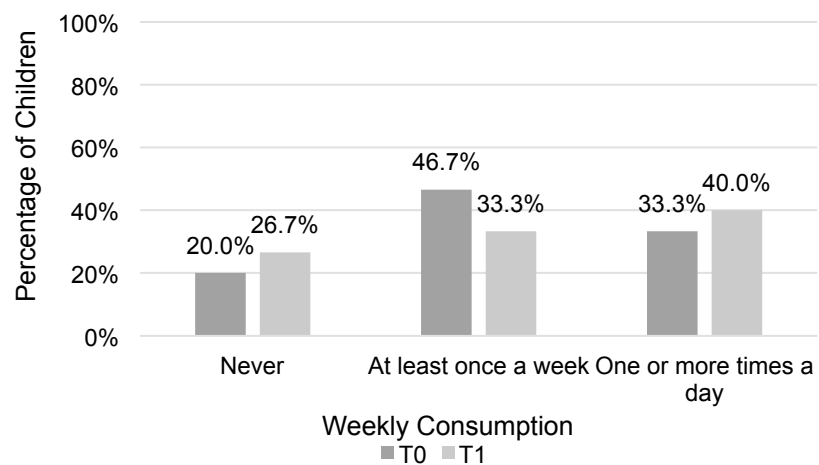
Vegetable Consumption - Intervention



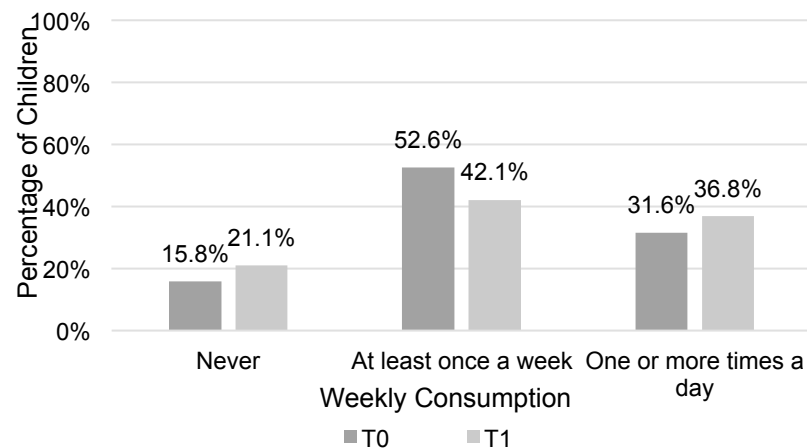
Vegetable Consumption - Control



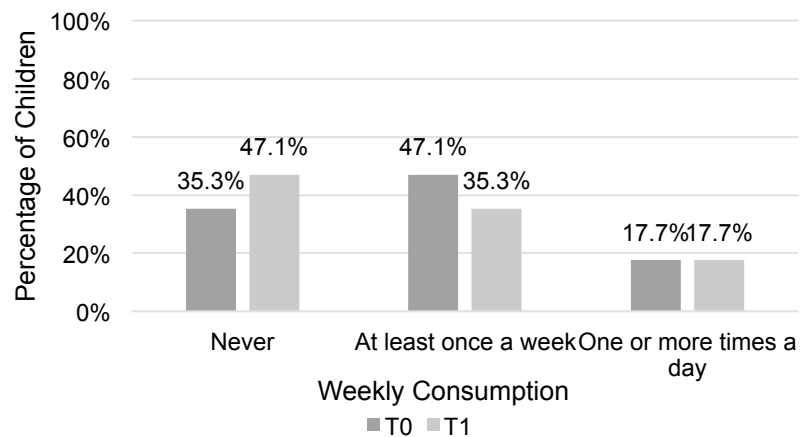
Snacks - Intervention



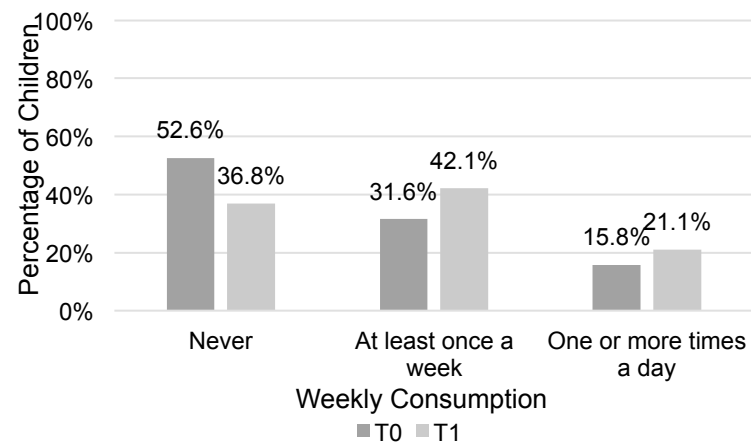
Snacks - Control



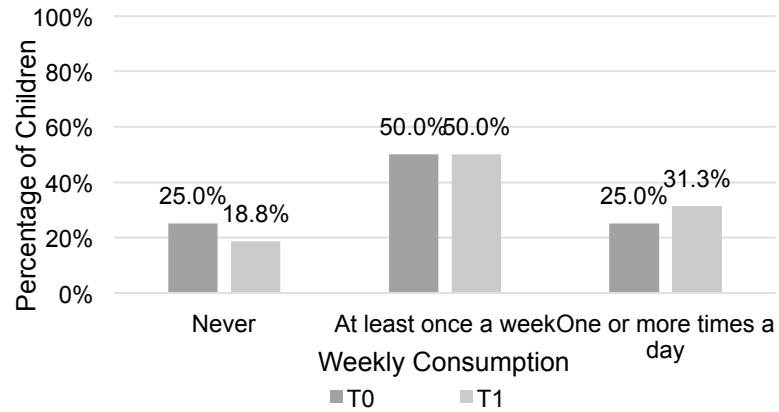
Fast Food Consumption - Intervention



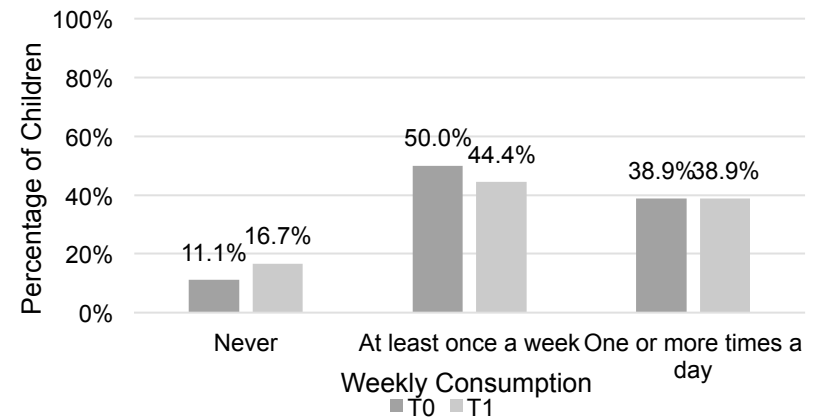
Fast Food Consumption - Control



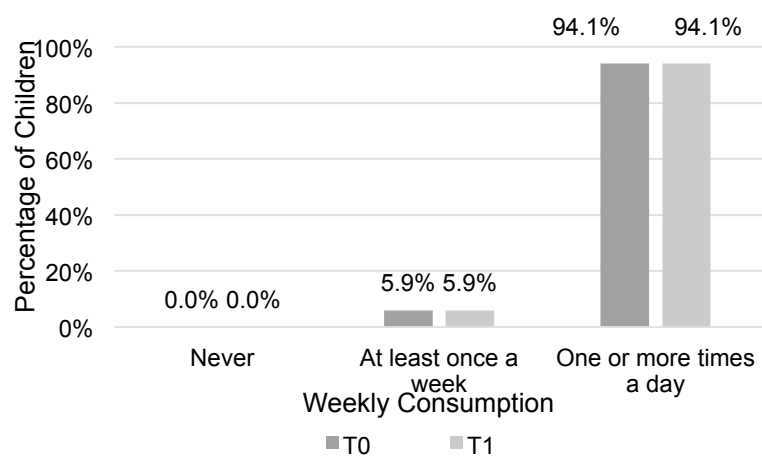
Sweets Consumption - Intervention



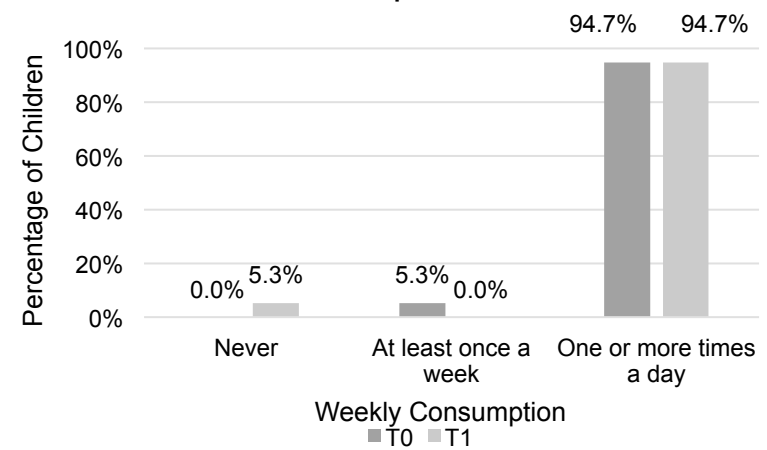
Sweets Consumption - Control



Milk Consumption - Intervention



Milk Consumption - Control



Appendix E. Survey Validity*

Food Group	Standardized α	Raw α	Validity
Low-fat dairy	0.727	0.634	Strong
Added sugar	0.678	0.586	Moderate
Lean meats	0.801	0.799	Strong
Eggs	0.698	0.577	Moderate
Cheese	0.725	0.620	Strong

*Questions were taken from the Rate Your Plate (RYP) and MEDFICTS measures. Standardized values were used to determine validity over raw values. Strong validity was determined if the standardized α was greater than 0.7.